POs

B.Tech (Electrical Engg.)

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

POs

B.Tech (Electrical and Computer Science Engg.)

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

POs

M.Tech-Power System Engg.

1. Acquire technical competence, comprehensive knowledge and understanding the methodologies and technologies of power system operation and control, principles, and practices of energy management.
2. Ability to apply the knowledge of mathematics, science, engineering, and technology. Understand in detail, analyses, formulate and solve the issues pertaining to the application of power system technologies.
3. Acquiring the ability to identify, investigate, understand and analyses complex problems pertaining to power management in power industries and identify effective solution strategies for implementation.
4. Inculcate the role of research in developing and maintaining knowledge of the state-of-the-art in various power technologies. Acquire the skill to design, develop and modify systems in hardware and software platforms to meet desired needs within realistic constraints.
5. Create, select, and apply appropriate techniques, resources, modern engineering to complex engineering activities in the field of power system, control and energy management
6. Acquire the capacity to understand and summarize complex information pertaining to various fields of engineering in industries. Function effectively as an individual, and as a member or leader in a team
7. Acquire the skill to develop specifications, implement and critically assess projects and their outcomes. Demonstrate management, leadership, and entrepreneurial skills, and apply these to one's own work, as a member and a leader in a team to manage projects in multidisciplinary environments.
8. Ability to communicate effectively in both oral and written contexts in the form of technical papers, project reports, design documents and seminar presentations.
9. Recognize the need for, and acquire the ability to engage in self-improvement through continuous professional development and life-long learning to maintain an up-todate knowledge of contemporary issues in various fields of engineering.
10. Apply and commit to professional ethics and responsibilities of engineering practice. Understand the importance of sustainability and cost effectiveness in design and development of engineering solutions for Ethical Practices and Social Responsibility industries and their impacts in societal and environmental context. Demonstrate awareness of societal, safety, health, legal and cultural issues relevant to professional engineering practice.
11. Impart an eagerness to conduct investigation and research on chosen field of study and thus keep moving towards being adaptive, self-reliant and self-evaluative.

PEOs

B.Tech (Electrical Engg.)

1. Fundamental knowledge in Mathematics, Physical sciences, Electrical Sciences and Engineering
2. Intensive training in problem solving, practical problems, laboratory skills, and design skills.
3. Specialization in specific areas of interest and excel as a professional at national and international levels
4. Development of analytical and research aptitude, so as to cope up with the changes in technology through lifelong learning.
5. Imparting an education that includes communication skills, the ability to work in a team with leadership quality, devoted to societal problems with an ethical attitude and the ability to engage in lifelong learning

PEOs

B.Tech (Electrical and Computer Science Engg.)

1. Fundamental knowledge in Mathematics, Physical sciences, Electrical Engineering and Computer Science Engineering.
2. Intensive training in problem solving, practical problems, laboratory skills, and design skills.
3. Specialization in specific areas of interest and excel as a professional at national and international levels
4. Development of analytical and research aptitude, so as to cope up with the changes in technology through lifelong learning.
5. Imparting an education that includes communication skills, the ability to work in a team with leadership quality, devoted to societal problems with an ethical attitude and the ability to engage in lifelong learning

PEOs

M.Tech-Power System Engg.

1. Intensive training in problem solving, practical problems, laboratory skills, and design skills.
2. Specialization in specific areas of interest and excel as a professional at national and international levels.
3. Development of analytical and research aptitude, to cope up with the changes in technology through lifelong learning.
4. Imparting an education that includes communication skills, the ability to work in a team with leadership quality, devoted to societal problems with an ethical attitude and the ability to engage in lifelong learning

PSOs

B.Tech (Electrical Engg.)

1. Fundamental knowledge in Mathematics, Physical sciences, Electrical Sciences and Engineering
2. Intensive training in problem solving, practical problems, laboratory skills, and design skills.
3. Specialization in specific areas of interest and excel as a professional at national and international levels
4. Development of analytical and research aptitude, so as to cope up with the changes in technology through lifelong learning.
5. Imparting an education that includes communication skills, the ability to work in a team with leadership quality, devoted to societal problems with an ethical attitude and the ability to engage in lifelong learning

PSOs

B.Tech (Electrical and Computer Science Engg.)

1. Apply principles of engineering, electronics and computer science, physics, chemistry, environmental science, mathematics (including discrete mathematics, linear algebra and complex variables) and laboratory skills for erection, testing, operation and maintenance of high current electrical systems, such as, electrical machines, power and energy systems
2. Model, analyse, design, and realize real time systems involving components of processes related to electrical and computer science engineering systems used in industries and homes.
3. Work with professional ethics in power system engineering, control systems engineering and different algorithms used in software industries
4. Graduates will be motivated for continuous self-learning in engineering practice and pursue research in advanced areas of Electrical and Computer Science Engineering in order to offer engineering services to the society, ethically.

PSOs

M.Tech-Power System Engg.

1. Demonstrate proficiency in use of software & hardware to be required to practice Power System engineering profession.
2. To critically evaluate the design and provide optimal solutions to problem areas in Power Generation Operation and Control
3. To adapt to emerging control technologies to innovate ideas and solutions to existing issues in the field of power system engineering.

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	**PY 101**	**Title of the Course**	**Physics**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	**I**	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Physics and Mathematics	**Co-requisite**	None				
Course Objectives	• The purpose of this undergraduate course is to impart basic knowledge of fundamental concept of physics which is necessary for a strong engineering knowledge base.						

Course Outcomes	
CO1	To analyze the connection between daily life observations and science. To realize that apparently different ideas of Optics such as Interference and Diffraction have interrelationship between them. To realize the simplicity of ideas involved in explaining complex phenomenon
CO2	To grow in ideas of different aspect of light and develop connection between daily life applications and science. To analyze the process of development of a new theory while dealing with Polarization. To correlate that the conceptualization of an idea is far ahead than its practical realization while dealing with LASER. To grow in realization of totally different manifestation of light. To find the most recent applications of light in terms of communication and storage of data. To realize that how the design of complex systems is based on the simple ideas. To realize that the conceptualization of an idea is far ahead than its practical realization while dealing with Optical Fibers.
CO3	To grow in developing connection between philosophy and science. To find that seemingly different ideas such as Optics and Mechanics have interrelationship between them. To understand the process of development of a new theory and its application in life. To realize the requirement of power of imagination.
CO4	To grow in developing the connection between philosophy and science. To find that seemingly different ideas such as Compton Effect and Quantum Theory have interrelationship between them. To understand and analyze the process of development of a new theory and how the development of one idea leads to the development of a apparently different idea. To realize and appreciate the efforts made by the individuals to give a new understanding of science that led to the modern day applications.
CO5	To grow in developing connection between daily life utility and material science. To realize that apparently different materials with respect to Electric and Magnetic properties have inter relationship between them. To evaluate that how totally different manifestation of Modern Science leads to new technology. To do the evaluation that how an idea is far ahead than its practical realization while dealing with Nano Technology and Super Conductivity.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Wave Optics**	Methods of formation of coherent sources, Fresnel's Bi-prism, displacement of fringes, thin film interference, Newton's ring. Fraunhoffer diffraction at single slit, grating, Rayleigh's criterion of resolution, resolving power of grating.	8	CO1
2	**Optical Activity and Modern Optics**	Production of plane polarized light by reflection and Double refraction, Nicol prism, Optical activity, polarimeter(Laurent's and Bi-quartz). Principle of fiber optics, numerical aperture, attenuation, dispersion in optical fibers, material dispersion, waveguide dispersion, intermodal and intra-modal dispersion, Pulse dispersion in step index fiber. Main components of laser, Einstein's coefficients, He-Ne laser, Nd-YAG laser and their applications.	8	CO2
3	**Properties of Matter and Relativistic Mechanics**	Viscosity, Poiseulli's equation, Michelson-Morley experiment and its implications, Galilean transformation equations, Lorentz transformation equations and their consequences, energy mass relation, relativistic kinetic energy.	8	CO3
4	**Quantum Physics**	Compton effect, basic postulates of quantum mechanics, Wave function and its physical admissibility, orthogonality of wave functions, normalization of wave functions, Heisenberg's uncertainty principle (no derivation) and its applications (non-existence of electron in nucleus, Bohr's radius), Schrodinger's equation and its application to free particle, particle in one dimensional box.	8	CO4
5	**Physics of Materials**	Magnetic Properties: Magnetization, Origin of magnetic moment, dia, para and ferro magnetism, Langevin's theory for diamagnetic material, Phenomena of hysteresis and its applications. Superconductors: Temperature dependence of resistivity in superconducting materials, Effect of magnetic field (Meissner effect), Temperature dependence of critical field, Type I and Type II superconductors, BCS theory (Qualitative), High temperature superconductors and Applications of Super-conductors. Nano-Materials: Basic principle of nanoscience and technology, structure, properties and uses of Fullerene and Carbon nanotubes, Applications of nanotechnology.	8	CO5

Reference Books:

1. Fundamentals of Optics by Jenkins and White.
2. Optical Fiber Communication by Gerd Keiser.
3. Concepts of Modern Physics by Arthur Beiser.

4. Introduction to Special Theory of Relativity by Robert Resnick
5. Quantum Physics by Eisberg.
6. Introduction to Nanotechnology by Poole Owens, Wiley India.
7. Solid State Physics by S.O. Pillai, New Age Publications.

e-Learning Source:

1. https://nptel.ac.in/courses/115/101/115101011/
2. https://nptel.ac.in/courses/115/107/115107095/
3. https://nptel.ac.in/courses/113/106/113106093/
4. https://nptel.ac.in/courses/115/101/115101107/

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	1	1	3	1	3	3	2	2	3	3	3	2	3		
CO2	3	3	3	2	1	1	2	2	2	1	3	2	3	2	2	3		
CO3	3	2	1	1	2	2	3	1	3	2	1	3	2	2	2	3		
CO4	3	2	2	2	3	3	1	2	2	3	2	2	3	2	2	3		
CO5	3	1	1	1	1	2	1	1	1	1	1	2	3	2	2	3		

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	LN101	**Title of the Course**	Basic Professional Communication	**L**	**T**	**P**	**C**
Year	**Ist**	**Semester**	II	**2**	**1**	**0**	**3**
Pre-Requisite	10+2	**Co-requisite**	**U.G. Program**				
Course Objectives	• The course aims to educate the students in both the artistry and utility of the English language for professional purposes through the study of language and literature. • The key component of the various types of professional communication is basically communication in the English language which is now a global language. • The Department of Languages caters to the needs of the students aspiring for training, expertise and excellence in professional communication with a marked emphasis on English for Specific/Special Purposes (ESP).						

Course Outcomes	
CO1	Students will be introduced to the basic understanding of communication and Professional Communication. Knowledge of Professional, cultural and cross-cultural communication will be imparted. Meaning and process of communication, verbal and nonverbal communication will be focused.
CO2	Learning Language through literature aims to develop the students' ability to read the prescribed essays and stories critically and to understand the historical-political and cultural dynamics underlying them.
CO3	Basic tools of communication and improvement in communicative competence.
CO4	Understanding the structural and functional grammar and basic structure of language.
CO5	Enhancement of writing skills in English i.e., writing application, report and various types of letters.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Professional Communication**	Professional Communication: Its Meaning and Importance, Essentials of Effective Communication, Barriers to Effective Communication	**8**	**CO 1**
2	**Language through Literature**	A. Essays: 1. The Effect of Scientific Temper on Man by Bertrand Russell 2. The Aim of Science and Humanities by Moody E. Prior B. Short Stories: 1. The Meeting Pool by Ruskin Bond 2. The Portrait of a Lady by Khushwant Singh	**8**	**CO 2**
3	**Basic Vocabulary**	Euphemism, One-word Substitution, Synonyms, Antonyms, Homophones, Idioms and Phrases, Common Mistakes, Confusable Words and Expressions, Portmanteau Words, Foreign Words and Expressions.	**8**	**CO 3**
4	**Basic Grammar**	Articles, Prepositions, Tenses, Concord, (Subject-Verb agreement), Modal Auxiliaries, Verbs: its Kinds and uses, Degrees of Comparison, Punctuation	**8**	**CO 4**
5	**Basic Composition**	Report Writing: What is report? Kinds and Objectives of reports, writing reports, Business Letter writing; Introduction to Business Letters, Layout of Business letters, Letters of Enquiry/Complaint Proposal writing	**8**	**CO 5**

Reference Books:

1. Gerson, Sharon J. *Technical Writing: Process and Product* (5th edition). Prentice Hall, 2005.
2. K. Floyd, *Interpersonal Communication: The Whole Story*. McGraw Hill, 2009.
3. Greenbaum, Sidney and Nelson Gerald, *An Introduction to English Grammar*. Routledge, 2009.
4. Swan, Michael, *Practical English Usage*. OUP, 2005.
5. Murphy, Raymond. *English Grammar in Use*. Cambridge University Press, 2019.
6. Kumar, Sanjay and Pushp Lata., Communication Skills. Oxford University Press, Oxford 2011.
7. Raman, Meenakshi, and Sangeeta Sharma. Technical Communication: Principals and Practice. Second Edition, Oxford University Press, 2012.
8. Gerson, Sharon J. *Technical Communication: Process and Product* (9th edition). Longman Pub., 2016.

e-Learning Source:

1. http://www.uptunotes.com/notes-professional-communication-unit-i-nas-
2. https://www.docsity.com/en/subjects/professional-communication/
3. https://lecturenotes.in/download/note/22690-note-for-communication-skills-for-profession...

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

2- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Teaching and Learning methods	Flipped Classrooms, Concept Mapping, Information-Based Approach, Personal-Response Approach, Language-Based Approach, Paraphrastic Approach, Moral-Philosophical Approach and Stylistics Approach
List/Topics/Activities Planned that are beyond Syllabus	Information-Based Activities, Personal-Response Activities, Language-Based Activities, Periphrastic Activities, Moral-Philosophical Activities, and Stylistics Activities

Integral University, Lucknow

Effective from Session: 2015-16							
Course Code	**MT101**	**Title of the Course**	**Mathematics I**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	**1st**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• The course is aimed to develop the skills in mathematics which is necessary for grooming them into successful engineering graduate. • The topics introduced will serve as basic tools for specialized studies in science field.						

Course Outcomes	
CO1	Able to calculate rank of matrix, characteristic equation & characteristic roots & use the applicability of Cay lay Hamilton Theorem to find inverse of matrix which is very important in many engineering application.
CO2	To develop ability to solve higher derivative, expansion of functions in ascending power of variable & partial derivatives.
CO3	Develops ability to solve Jacobian, error and approximation and Extrema of the function.
CO4	Learn the evaluation policy of some special function like gamma & Beta function. & their relation which is helpful to evaluate some definite integral arising in various branch of Engineering.
CO5	Able to determine vector differentiation and integration.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Differential Equations**	Linear differential equations of first order, Linear differential equations of higher order with constant coefficients,Complementary functions and particular integrals, Simultaneous linear differential equations, Solution ofsecond order differential equations by changing dependent and independent variables, Method of variation ofparameters, Applications to engineering problems (without derivation).	8	CO1
2	**Laplace Transform**	Laplace transform, Existence theorem, Laplace transform of derivatives and integrals, Unit stepfunction, Dirac-delta function, Laplace transform of periodic functions, Inverse Laplace transform, Convolutiontheorem, Applications to solve simple linear and simultaneous differential equations.	8	CO2
3	**Fourier Series and Partial Differential Equations**	Periodic functions, trigonometric series, Fourier series of period 2 π, Euler's formulae, functions havingarbitrary period, change of interval, Even and odd functions, Half range sine and cosine series. Introduction of partial differential equations, linear partial differential equations with constant coefficients ofsecond order and their classifications to parabolic, 9 elliptic and hyperbolic forms with illustrative examples.	9	CO3
4	**Applications of Partial Differential Equations**	Method of separation of variables for solving partial differential equations, Wave equation up to two-dimensions,Laplace equation in two-dimensions, Heat conduction equations up to two dimensions, Equations of transmissionLines.	8	CO4
5	**Basic Statistics and curve fitting**	Mean, Median, Mode, Standard deviation and Variance, Method of least squares, Curvefitting of straight line and parabola.	7	CO5

Reference Books:

1. E. Kreyszig Advanced Engineering Mathematics, Wiley Eastern Ltd.
2. Jaggi and Mathur Advanced Engineering Mathematics, Khanna Publication.
3. B. S. Grewal Higher Engineering Mathematics, Khanna Publication.
4. Dennis G. Zill Advanced Engineering Mathematics, CBS Publication.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	1	1	3						3	3	3	2	3		
CO2	3	3	3	2	1	1						2	3	2	2	3		
CO3	3	2	1	1	2	2	3					3	2	2	2	3		
CO4	3	2	2	2	3	3						2	3	2	2	3		
CO5	3	1	1	1	1	2	1					2	3	2	2	3		

3- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session:							
Course Code	**PY102 / PY104**	**Title of the Course**	**Physics Lab**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	**1st**	**0**	**0**	**6**	
Pre-Requisite	10+2 with Physics and Mathematics	**Co-requisite**					
Course Objectives	The purpose of this undergraduate course is to impart practical knowledge of the concepts through different experiments related to its theoretical course.						

Course Outcomes	
CO1	To demonstrate how interference takes place by division of amplitude and by division of wavefront.
CO2	To demonstrate the practical applications of polarization phenomenon in finding the specific rotation, refractive index and Brewster's angle.
CO3	To demonstrate the practical application of Fraunhoffer diffraction in wavelength and focal length calculation.
CO4	To demonstrate the magnetic and heating effect of current in finding the magnetic field and Stefan's constant.
CO5	To demonstrate how to calculate the energy band gap of a semiconductor material and viscosity of a liquid.

List of experiments	Content of Unit
Exp.1	To determine the wave length of monochromatic light by Newton's ring.
Exp.2	To determine the wave length of monochromatic light with the help of Fresnel's Biprism.
Exp.3	To determine the focal length of two lenses by nodal slide and locate the position of cardinal points.
Exp.4	To determine the specific rotation of cane sugar solution using Half Shade polarimeter.
Exp.5	To determine the wavelength of spectral lines using plane transmission grating.
Exp.6	To determine the Brewster's angle and refractive index of material with the help of a laser source.
Exp.7	To determine the variation of magnetic field along the axis of a current carrying coil and then to estimate the radius of the coil.
Exp.8	To verify Stefan's law by electrical method.
Exp.9	To determine the energy band gap of a given semiconductor material.
Exp.10	To determine the coefficient of viscosity of a liquid.

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	1	3	1	3	-	-	-	-	-	2	1	1	3	-	-
CO2	2	2	2	2	2	3	2	-	-	-	-	-	2	1	1	3	-	-
CO3	3	3	1	3	3	1	3	-	-	-	-	-	2	1	1	3	-	-
CO4	2	2	2	3	1	2	2	-	-	-	-	-	2	1	1	3	-	-
CO5	2	1	1	1	2	2	2	-	-	-	-	-	2	1	1	3	-	-

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE104**	**Title of the Course**	**Electrical Engineering Lab**	**L**	**T**	**P**	**C**
Year	**I**	**Semester**	I/II	**0**	**0**	**2**	**1**
Pre-Requisite		**Co-requisite**					
Course Objectives	• To understand and experiment with the verification of DC Network Theorems • To understand and experiment with the study of diode, rectifier, BJT characteristics and Amplifier • To understand and experiment with the study of resonance and determination of transformer losses • To understand and experiment with the calibration of energy meter and operation of induction motor						

Course Outcomes	
CO1	Adopt, perform, analyze and implement the methods of verification of DC Network Theorems; contribute in related development
CO2	Adopt, perform, analyze and implement the methods of study of diode, rectifier, BJT characteristics and Amplifier; contribute in related development
CO3	Adopt, perform, analyze and implement the methods of study of resonance and determination of transformer losses; contribute in related development
CO4	Adopt, perform, analyze and implement the methods of calibration of energy meter and operation of induction motor; contribute in related development

Unit No.	Title of the Unit	Content of Experiment	Contact Hrs.	Mapped CO
1.		Verification of Thevenin's Theorem.	2	1
2.		Verification of Superposition Theorem.	2	1
3.		Verification of Maximum Power Transfer Theorem.	2	1
4.		To study V-I characteristics of diode.	2	2
5.		To study the input & output characteristics of BJT in CE configuration.	2	2
6.		To study the full wave rectifier circuit with & without filter and determine the ripple factor.	2	2
7.		To study the phenomenon of resonance in series RLC circuit.	2	3
8.		Determination of losses in single phase transformer by OCT and SCT.	2	3
9.		To calibrate a single-phase induction type energy meter.	2	4
10.		To study the running and reversing of a three phase SCIM.	2	4
11.		Study of OP Amp based inverting and non-inverting amplifier	2	2

Reference Books:

1. V.Deltoro, “Principle of Electrical Engg.” PHI, 2009.
2. M.A Mallick, Dr. I. Ashraf, “Fundamental of Electrical Engg,” CBS Publishers, 2010.
3. A. Hussain, “Basic Electrical Engg” Dhanpat Rai & sons, 2007.
4. R. Boylestad, “Electronic Devices and Circuit Theory”, Pearson, 2013.

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)															
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	1	1	3						3	3	3	2	3
CO2	3	3	3	2	1	1						2	3	2	1	3
CO3	3	2	1	1	2	2	3					3	3	3	2	3
CO4	3	2	2	2	3	3						2	3	2	2	3

6- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2015-16							
Course Code	ME103	**Title of the Course**	ENGINEERING GRAPHICS	**L**	**T**	**P**	**C**
Year	**I**	**Semester**	I/II	**0**	**0**	**2**	**1**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Main objective is to teach the fundamentals of Engineering Graphics. • This course enhances visualization skill and imagination power. • To understand techniques of drawings for various fields of engineering • To improve their technical communication skill in the form of communicative drawings.						

Course Outcomes	
CO1	Describe the fundamentals of engineering drawing, use of geometrical instruments and drawing steps
CO2	To understand the concept of projection and acquire visualization skills, draw the projection of points, lines and planes.
CO3	Classify solids and projection of solids at different positions
CO4	To get the exact sectioned view of solids and development of their surfaces.
CO5	To draw isometric projection and perspective views of an object.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Lettering and geometrical constructions	Describe the fundamentals of engineering drawing, use of geometrical instruments and layout for initial drawing.	2	CO1
2	Orthographic projections of points	Describe the fundamentals orthographic projections and use of geometrical instruments and layout for initial drawing.	2	CO2
3	Projections of lines	Describe the fundamentals of projections of lines and use of geometrical instruments and procedure for the drawing.	2	CO2
4	Projections of solids	Describe the fundamentals of projections of solids and use of geometrical instruments and procedure for the drawing.	2	CO3
5	Sectioning of solids	Describe the fundamentals of sectioning of solids and use of geometrical instruments and procedure for the drawing.	2	CO4, CO3
6	Isometric Projections	Describe the fundamentals of Isometric projections and use of geometrical instruments and procedure for the drawing.	2	CO5
7	Production drawing	Describe the fundamentals of production drawing.	2	CO1, CO2

Reference Books:

Engineering graphics by Pradeep Jain

Engineering graphics by Krunal Patel

e-Learning Source:

https://www.youtube.com/watch?v=p62LPzFqGQw&list=PLp6ek2hDcoNCjoRLQ4rjpCozisCACBxKA

https://www.youtube.com/watch?v=VrU73IwRyc4&list=PLLy_2iUCG87Bw9XPfEF3r3EW5UlAOv8iz

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3								1	2		3	3		3
CO2	3	2	2						1	2		3	3		3
CO3	3	2	2						1	2		3	3		3
CO4	3	2	2						1	2		3	3		3
CO5	3	2	2						1	2		3	3		3

7- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2015-16							
Course Code	ME104	**Title of the Course**	WORKSHOP PRACTICE	**L**	**T**	**P**	**C**
Year	**I**	**Semester**	I / II	0	0	2	1
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To impart practical knowledge and hands-on practice on the lathe machine. • To impart practical knowledge of basic tools and operations in the fitting shop and carpentry shop. • To impart basic knowledge of smithy tools and hands-on practice in smithy shop. • To impart basic knowledge of different welding tools and equipment and hands-on practice of making different welding joints. • 5. To impart practical knowledge of different types of sheet metal tools and equipments and hands-on practice of making sheet metal components.						

Course Outcomes	
CO1	Perform different operations on lathe machine.
CO2	Manufacture components using tools and equipments of fitting shop and carpentry shop.
CO3	Make components in smithy shop using different types of smithy tools and equipments.
CO4	Perform different joining operations using welding tools and equipments.
CO5	Make sheet metal components using different sheet metal tools and equipments.

Experiment No.	**Title of the experiment**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Lathe machine**	To study and sketch a lathe machine Practice of operations - facing, plain turning, step turning, Taper turning & chamfering	2	CO1
2	**Fitting shop & carpentry shop**	To study and sketch fitting tools and equipment Practice of step cutting, filing, drilling & tapping To make a 90^0 v-groove fitting on mild steel flat To study and sketch different types of carpentry tools & machines To make a mortise and tenon joint To make a corner lap joint	2	CO2
3	**Smithy shop**	To study and sketch different smithy tools & equipments To make a squire punch from mild steel round rod To make a pipe hook from a mild steel round rod	2	CO3
4	**Welding shop**	To study and sketch the welding equipments and tools To weld the two given plates & make a lap joint(by arc welding) To weld the two given plates & make a butt joint (by arc welding)	2	CO4
5	**Sheet metal**	To study and sketch different sheet metal tools & equipments To make a rectangular tray To make a conical funnel	2	CO5
e-Learning Source:				
https://www.vlab.co.in/				

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4
CO1	3	2	2	3	3	2			2		2	3	3	2	3
CO2	3	2	2	2	2	2			2		2	3	3	2	3
CO3	2	2	2	2	2	2			2		2	3	3	2	3
CO4	2	2	2	2	3	2			2		2	3	3	2	3
CO5	2	2	2	2	2	2			2		2	3	3	2	3

8- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2015-16							
Course Code	**CH101**	**Title of the Course**	**Chemistry**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	**2nd**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• The core is aimed to develop the skills in Chemistry which is necessary for grooming shes in casal engineering graduate. • The topics introduced will serve as basic tools for specialized studies in science field.						

Course Outcomes	
CO1	Analyze and compare magnetic behavior and stability of heteronuclear diatomic molecules, Significance of hydrogen bonding band theory, radius ratio, density of unit cell, fullerenes and graphite
CO2	Comprehension of types of polymers to make an appropriate choice of use of polymers (Natural, synthetic and biodegradable)
CO3	Compare reaction intermediates and mechanism of chemical reactions and isomerism.
CO4	Interpret phase rule, phase diagram, corrosion and its prevention, calculation of activation energy, rate constant, half-life period, emf of electrochemical cells, construction and operation of galvanic cell and concentration cells.
CO5	Determination of calorific value, analyzing water softening methods, principles, instrumentations of UV, IR and NMR spectroscopy and their applications.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Chemical bonding and state of matter:**	Molecular theory of hetero diatomic molecules, Band theory of bonding in metals, Hydrogen bonding. Solid state chemistry: Radius ratio rule, Space lattice (only cubes), Types of Unit cells, Bragg's law, calculation of density of unit cell. One and Two Dimensional solids, Graphite as two dimensional solid and its conducting and lubricating properties. Fullerene and its applications.	8	CO1
2	**Polymers:**	Polymerization and its classification, Thermoplastic and thermosetting resins. Elastomers (Buna-S, Buna-N, thiokols, polyurethanes, silicons), Polyamides (Nylon-6, Nylon-6,6, Nylon-6,10, Nylon-11, Kevlar), Polyesters (Terelene), Polyacrylates (PMMA, PAN, PVC). Organic conducting and biodegradable polymers.	8	CO2
3	**Structural and mechanistic concepts in organics:**	Stability of reaction intermediates, e.g. Carbanions, Carbocations and free radicals. Types of organic reactions, mechanism of nucleophilic substitutionreactions. Mechanism of the following name reactions. i. Aldolcondensation ii. Cannizzaro reactioniii. Beckmann rearrangement iv. Hofmann rearrangement and v. Diels-Alderreaction E-Z Nomenclature. R.S configuration, Optical isomerism of organic compounds containing one chiral center. Examples of optically active compounds without chirality. Conformations of n-butane.	8	CO3
4	**Reaction kinetics, Phase rule, Electrochemistry and Corrosion:**	Order and molecularity of reactions. First and second order reactions. Energy ofactivation. Phase Rule, its application to one component system(water). Equilibrium potential, electrochemical cells (galvanic and concentrationcells) Electrochemical theory of corrosion and protection ofcorrosion.	8	CO4
5	**Analytical methods, Fuel and Water treatment:**	Basic principles of spectroscopic methods. The use of UV, Visible, IR, 1HNMR, for the determination of structure of simple organic compounds. Classification of fuels, determination of gross and net calorific values using Bomb Calorimeter. Hardness of water, softening of water by Lime-Soda process, Zeolites and ion exchange resins process and Reverse Osmosis. Treatment of boiler feed water by Calgon process.	8	CO5

Reference Books:

1. Jain P. C. and Jain M. 1994. Engineering Chemistry. Danpat Rai publishing company Pvt. Ltd., Delhi.
2. Bahl B.S, Arun Bahl and Tuli B.D. 2007. Essentials of Physical Chemistry. S. Chand and Co. Ltd., Delhi.
3. Industrial Chemistry B.K Sharma, Goel publishing house.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	1	1	3						3	3	3	2	3		
CO2	3	3	3	2	1	1						2	3	2	2	3		
CO3	3	2	1	1	2	2	3					3	2	2	2	3		
CO4	3	2	2	2	3	3						2	3	2	2	3		
CO5	3	1	1	1	1	2	1					2	3	2	2	3		

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2015-16							
Course Code	**ES101**	**Title of the Course**	**Environmental Studies**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	**2nd**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• The purpose of this undergraduate course is to impart basic and key knowledge of environment and ECOsystem. • This will help students in enhancing their knowledge of biodiversity and its conservation. • After successful completion of course, the student will able to explore concept of the subject into their respective dimensions.						

Course Outcomes	
CO1	Gain knowledge about environment and ECOsystem.
CO2	Students will learn about natural resource, its importance and environmental impacts of human activities on natural resource.
CO3	Gain knowledge about the conservation of biodiversity and its importance.
CO4	Aware students about problems of environmental pollution, its impact on human and eCOsystem and control measures.
CO5	Students will learn about increase in population growth and its impact on environment.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction to Environment and ECOsystems**	Environment, its components and segments, Multidisciplinary nature of Environmental studies, Concept of Sustainability and sustainable development, Environmental movements, ECOsystem, Structure & Function, Energy flow in the ECOsystem, Ecological Pyramids and Ecological Succession.	8	CO1
2	**Natural Resources**	Renewable and non renewable, Soil erosion and desertification, Deforestation, Water: Use and over exploitation, Impacts of large Dams, Case studies.	8	CO2
3	**Biodiversity and Conservation**	Levels of biological diversity, Hot spots of biodiversity, India as a Mega Diversity Nation, Endangered and endemic species of India, Threats to Biodiversity, Conservation of Biodiversity, ECOsystem and biodiversity services.	8	CO3
4	**Environmental Pollution, Policies and Practices**	Environmental pollution, Solid waste management , Ill effects of fireworks, Climate change, Ozone layer depletion, acid rain and impacts on human communities and Environment, Environmental Laws: Environment Protection Act, Wildlife protection Act, Forest conservation Act, Convention on Biological Diversity (CBD), Tribal rights, Human wildlife conflicts.	8	CO4
5	**Human Population and the Environment**	Human population growth: Impacts on environment, human health and welfare, Resettlement and rehabilitation of project affected persons, Environmental ethics, Environmental communication and public awareness, case studies.	8	CO5

Reference Books:

1.Agarwal, K.C. 2001 Environmental; Biology, Nidi Pub. Ltd. Bikaner

2. Bharucha Erach, The Biodiversity of India, Mapin Pub. Pvt. Ltd., Ahemdabad-380, India

3. Brunner R.C. 1989. Hazardous waste incineration, Mc Graw Hill

4. Clark R.S. Marine Pollution, Clanderon Press Oxford (TB)

5. Cunningham W.P.2001.Cooper, T.H. Gorhani, E & Hepworth, Environmental encyclopedia, Jaicob Publication House, Mumbai.

6. De. A.K. Environmental chemistry Willey Eastern Limited.

7. Glick, H.P.1993 water in crisis, Pacific Institute for studies in dev, Environment & security, Stockholm Env, Institute, Oxford Univ, Press 473 p.

8. Hawkins R .E. Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay.

9. Heywood, V.H. & Watson, R. T.1995.Global biodiversity Assessment .Cambridge Univ. Press 1140 p.

10. Jadhave, H. and Bhosale, V. M. 1995 Environmental protection and laws, Himalaya pub, house, Delhi.284 p.

11. Mckinnery, M.L. and School, R. M.1996 Environmental science systems and solutions, web enhanced edition 639 p.

12. Mhaskar A.K. Matter Hazardous, Techno Science Pub (TM)

13. Miller T.G. Jr, Environmental Ecology, W. B. Saunders Co.USA,574 p. 16

14. Odum, E.P.1997.Fundamental chemistry, Goel Pub House Meerut.

15. Survey of the Environment, The Hindu (M).

16. Sharma B.K.2001.Environmental Chemistry, Goel Pub .House Meerut

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	1	1	3						3	3	3	2	3		
CO2	3	3	3	2	1	1						2	3	2	2	3		
CO3	3	2	1	1	2	2	3					3	2	2	2	3		
CO4	3	2	2	2	3	3						2	3	2	2	3		
CO5	3	1	1	1	1	2	1					2	3	2	2	3		

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2015-16							
Course Code	**MT112**	**Title of the Course**	**Mathematics II**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	**2nd**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• The course is aimed to develop the skills in mathematics which is necessary for grooming them into successful engineering graduate. • The topics introduced will serve as basic tools for specializedstudies in science field						

Course Outcomes	
CO1	Solve first order linear equations and higher order differential equation of certain types and interpret the solutions.
CO2	To use shift theorems to compute the Laplace transform, inverse Laplace transform and the solutions of second order, linear equations with constant coefficients.
CO3	Able to determine given function in terms of sine and cosine terms in Fourier series.
CO4	Apply problem-solving using concepts and techniques from PDE'S and Fourier analysis applied todiverse situations in physics, engineering, financial mathematics and in other mathematical contexts.
CO5	Apply method of least squares to find the curve of best fit for the given data

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Differential Equations**	Linear differential equations of first order, Linear differential equations of higher order with constant coefficients, Complementary functions and particular integrals, Simultaneous linear differential equations, Solution ofsecond order differential equations by changing dependent and independent variables, Method of variation ofparameters, Applications to engineering problems (without derivation).	8	CO1
2	**Laplace Transform**	Laplace transform, Existence theorem. Laplace transform of derivatives and integrals, Unit stepfunction, Dirac-delta function, Laplace transform of periodic functions, Inverse Laplace transform, Convolutiontheorem, Applications to solve simple linear and simultaneous differential equations.	8	CO2
3	**Fourier Series and Partial Differential Equations**	Periodic functions, trigonometric series, Fourier series of period 2 n. Euler's formulac, functions havingarbitrary period, change of interval, Even and odd functions, Half range sine and cosine series. Introduction of partial differential equations, linear partial differential equations with constant coefficients ofsecond order and their classifications to parabolic, elliptic and hyperbolic forms with illustrative examples.	8	CO3
4	**Applications of Partial Differential Equations**	Method of separation of variables for solving partial differential equations, Wave equation up to two-dimensions,Laplace equation in two-dimensions, Heat conduction equations up to two dimensions, Equations of transmissionLines.	8	CO4
5	**Curve fitting and Solution of Equations**	Method of least squares, curve fitting of straight line and parabola, Solution of cubic and biquadratic equations.	8	CO5

Reference Books:

1. E. Kreyszig Advanced Engineering Mathematics, Wiley Eastern Ltd.
2. Jaggi and Mathur Advanced Engineering Mathematics, Khanna Pub.
3. B. S. Grewal Higher Engineering Mathematics, Khanna Pub.
4. Dennis G. Zill Advanced Engineering Mathematics, CBS Pub.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	1	1	3						3	3	3	2	3		
CO2	3	3	3	2	1	1						2	3	2	2	3		
CO3	3	2	1	1	2	2	3					3	2	2	2	3		
CO4	3	2	2	2	3	3						2	3	2	2	3		
CO5	3	1	1	1	1	2	1					2	3	2	2	3		

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2015-16							
Course Code	**ME101**	**Title of the Course**	**Basic Mechanical Engg.**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	**2nd**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Be able to have the basic concepts of thermal sciences and temperature measurement on the basis of zeroth law of thermodynamics. • To understand and apply first and second law of thermodynamics to various processes and real systems. • Be able to model the problem using free-body diagrams and reach to solution by using equilibrium equations. • Be able to draw Shear Force Diagram (SFD) and Bending Moment Diagrams (BMD) for statistically determinate beams. • Be able to design simple components on the basis of knowledge of stress, strain and strength of material.						

Course Outcomes	
CO1	Explain basic concepts of thermal sciences and temperature measurement on the basis of zeroth law of thermodynamics.
CO2	Understand and apply first and second law of thermodynamics to various processes and real systems.
CO3	Model the problem using freebody diagrams and reach to solution by using equilibrium equations.
CO4	Draw Shear Force Diagram (SFD) and Bending Moment Diagrams (BMD) for statistically determinate beams.
CO5	D esign simple components on the basis of knowledge of stress, strain and strength of material.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**FUNDAMENTALS OF THERMODYNAMICS**	Fundamental Concepts and Definitions: Definition of Thermodynamics, System, surrounding and universe, Phase, Concept of continuum,Macroscopic & microscopic point of view. Density, Specific volume, Pressure, temperature. Thermodynamic equilibrium, Property, State, Path, process, Cyclic process, Energy and its form, Work and heat, Enthalpy.Laws of thermodynamics: Zeroth law: Concepts of Temperature, Zeroth law.	8	CO1
2	**FIRST LAW &SECOND LAW**	First law: First law of thermodynamics. Concept of processes, Flow processes and control volume,Flow work. Steady flow energy equation, Mechanical work in a steady flow of process. Second law: Essence of second law. Thermal reservoir, Heat engines, COP of heatpump and refrigerator Statements of second law, Carnot cycle, Clausius inequality.	8	CO2
3	**MECHANICS AND STRENGTH OF MATERIALS**	Force system and Analysis: Basic Concept: Laws of motion. Transfer of force to parallel position. Resultant of planer force system Free Body diagrams, equilibrium and its equation. Friction: Introduction, Laws of Coulomb friction, Equilibrium of bodies involving dry friction, belt friction.	8	CO3
4	**STRUCTURE ANALYSIS**	Beams: Introduction, Shear force and bending moment, Shear and bending moment diagram for staticallydeterminate beams.	8	CO4
5	**STRESS AND STRAIN ANALYSIS**	Simple Stress and strain: Introduction, Normal, shear stresses, Stress-strain diagrams for ductile andbrittle materials. Pure Bending of Beams: Introduction, Simple bending theory.	8	CO5

Reference Books:

1. Van Wylen G.J. &Sonnlog R.E. Fundamentals of Classical Thermodynamics, John Wiley & Sons, Inc. NY.
2. Wark Wenneth: Thermodynamics (2nd edition) Mc Graw Hill Book Co. NY.
3. Holman, J.P: Thermodynamics, Mc Graw Hill Book Co.NY.
4. Shames LH, Engineering Mechanics, P.H.L.
5. D.S. Kumar, Mechanical Engineering, S.K. Katarial& Sons.
6. BhaviKatti S.S. Engineering Mechanics, New Age Pub,
7. P.K. Bharti: Engineering Mechanics, Kataria and Sons.
8. R.K. Rajput, Mechanical Engineering. Laxmi Pub

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	1	1	3						3	3	3	2	3		
CO2	3	3	3	2	1	1						2	3	2	2	3		
CO3	3	2	1	1	2	2	3					3	2	2	2	3		
CO4	3	2	2	2	3	3						2	3	2	2	3		
CO5	3	1	1	1	1	2	1					2	3	2	2	3		

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2015-16							
Course Code	**CS101**	**Title of the Course**	**Computer Programming**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	**2nd**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To give knowledge of computers, networks, algorithms & flowcharts. • To provide fundamental concepts of programming language "C". • To show the use of functions and pointers to different problems • To study the implementation of arrays, matrices and strings. • To give concepts of user defined data types structure & union.						

Course Outcomes	
CO1	Understand basic concepts of computer, networks and formulation of algorithmic solutions to problems.
CO2	Understanding of programming concepts of C language and their implementation.
CO3	Analyze and develop programs on pointers and functions.
CO4	Develop programs on different operations on arrays, matrices & strings.
CO5	Implement programs on structure, union & Dynamic memory allocation.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction to Computers**	Generation of computers, Characteristic and classifications of computers. Components of Computer: CPU, Various I/O Devices, Memory & its types, (Memory Hierarchy, Storage Media), Computer Software and their types, Operating System. Computer Networks & Communication: LAN, MAN, WAN, Network Topologies, Modes of Data Communication. Introduction to Internet and its Safeguard: Internet Addresses, Domain Name System, URL, Web Browsers Search Engines, Firewalls, Anti-Virus, Translators. Algorithm and flowchart: Algorithm and flow chart characteristics, Sketching Flowcharts of various problems.	8	CO1
2	**Starting C**	Standard I/O in 'C', 'C' Fundamental, C Character set, Constants, Variables, Keywords and Identifiers, Data types. Declaration. Operators and Expressions. Conditional statements (If, If-else), Nesting of if- else statement, switch statement, The? operator, goto statement. Decision making and Looping (While, Do-While, for). Break and Continue statements, Case Control Structures (Switch), C programs based on above concepts.	8	CO2
3	**Introduction to pointers**	Declaration and initialization of pointers, accessing the address of the variable, accessing the variable through the pointer, chain of pointers, pointers operators, pointer arithmetic Introduction to Functions: Need of "C" function, User Defined and Library Functions, Prototype of Function, Call by Value; Call by Reference; Nesting of Functions, Recursion. Pointers with function, C program based on above concept.	8	CO3
4	**Array**	Concept of One Dimensional and Multi-Dimensional arrays, Declaration, Operations: insert, delete, search, traverse, and merge, matrix operations, Sorting: Bubble sort, merge sort, insertion sort. Character array and strings: declaring and initializing strings variable, reading and writing a character, reading and writing strings from terminal, Arithmetic operations on characters, string handling functions. Application of pointers, and function on array, C program based on above concept.	8	CO4
5	**Structures**	Defining Structure, Declaration of Structure Variable, Accessing Structure members, copying and comparing structure variable, operation on individual member, nesting of structures, Array of structures. Application of pointers and function on Structures. Union Defining Union Declaration of Union, difference between structure and Union, Introduction of Static and Dynamic memory allocation- The process of Dynamic memory allocation, C program based on above concept.	8	CO5

Reference Books:

1. Foundation of Information Technology by 'D.S. Yadav'- New age International
2. Programming in 'C' by 'E Balagurusamy. -TMH Publication.
3. Let us 'C' by 'YashwantKanitkar-BPB Publication.
4. The C Programming Essentials by Dey- Pearson Publication.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	1	1	3						3	3	3	2	3		
CO2	3	3	3	2	1	1						2	3	2	2	3		
CO3	3	2	1	1	2	2	3					3	2	2	2	3		
CO4	3	2	2	2	3	3						2	3	2	2	3		
CO5	3	1	1	1	1	2	1					2	3	2	2	3		

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2019-20							
Course Code	CH102	**Title of the Course**	Engineering Chemistry Lab	**L**	**T**	**P**	**C**
Year	First	**Semester**	II	**0**	**0**	**2**	**2**
Pre-Requisite	10 + 2 with Chemistry	**Co-requisite**					
Course Objectives	• To understand qualitative and quantitative problems • Improvement of practical/technical skills. • Ability to work effectively and safely in a laboratory environment. • Enhancing communication skill.						

Course Outcomes	
CO1	Analysis of iron ore.
CO2	Study of water quality parameters.
CO3	Study of Iodometric titration.
CO4	Comprehension of principle, instrumentation and use of UV-VIS spectrophotometer and pH meter.
CO5	Detection of functional groups and elements in organic compounds.

Unit No.	Title of the Experiment	Content of Unit	Contact Hrs.	Mapped CO
1	**Iron content**	To determine the Iron content in the given iron ore by using external indicator.	2	1
2	**Alkalinity**	To determine the Alkalinity in the given water sample.	2	2
3	**Chloride content**	To determine the Chloride content in the given water sample by Mohr's method. (Argentometric method).	2	2
4	**Available chlorine**	To determine the Percentage of Available Chlorine in the given sample of Bleaching powder iodometrically.	2	3
5	**Hardness**	To determine the temporary and permanent hardness in water sample by Complexometric titration using EDTA as standard solution.	2	2
6	**Chemical displacement**	To determine the Equivalent weight of Iron by Chemical Displacement method. (The Equivalent weight of copper is 63.5)	2	3
7	**pH metric determination**	To determine the strength of given HCl solution by titrating it against NaOH solution using pH meter.	2	4
8	**Spectrophotometric measurement**	To determine the iron concentration in the given water sample by Spectrophotometer using potassium thiocyanate as color developing agent.	2	4
9	**Functional group detection**	To detect the presence of functional groups in the given organic compound.	2	5
10	**Elements detection**	To detect the presence of Elements in the given organic compound.	2	5

Reference Books:

Fundamentals of Chemistry with Quantitative analysis-I, R.L. Madan., S.Chand Publications

Advance Practical Chemistry: Jagdamba Singh, L.D.S Yadav, Jaya Singh, I.R. Siddiqui, PragatiEdition.

Practical Organic Chemistry, A.I.Vogel.

e-Learning Source:

https://www.bing.com/videos/search?q=functinal+group+detection&&view=detail&mid=F232CD67537BBA0CC3EBF232CD67537BBA0CC3EB&&FORM=VRDGAR&ru=%2Fvideos%2Fsearch%3Fq%3Dfunctinal%2520group%2520detection%26qs%3Dn%26form%3DQBVR%26%3D%2525eManage

https://www.bing.com/videos/search?q=alkalinility+of+water+sample&qpvt=alkalinility+of+water+sample&view=detail&mid=7AF6506DB69D2C2F3EA37AF6506DB69D2C2F3EA3&&FORM=VRDGAR&ru=%2Fvideos%2Fsearch%3Fq%

https://www.bing.com/videos/search?q=iodometric+titration&qpvt=Iodometric+titration&FORM=VDRE

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)															
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	-	-	-	-	2	1	2	2	-	2	3	1	-	-
CO2	3	2	2	-	-	-	2	1	2	2	-	2	3	3	-	1
CO3	3	2	-	-	-	-	2	1	2	2	-	2	3	2	-	-
CO4	3	2	-	2	1	-	2	1	2	2	-	2	3	2	-	-
CO5	3	2	-	-	-	-	2	1	2	2	-	2	3	-	-	-

9- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2015-16							
Course Code	ME102	**Title of the Course**	MECHANICAL ENGINEERING LAB	**L**	**T**	**P**	**C**
Year	**I**	**Semester**	II	**0**	**0**	**2**	**1**
Pre-Requisite	NONE	**Co-requisite**	NONE				
Course Objectives	• To understand the working and basic components of 4 stroke petrol engine and 4 stroke Diesel engine through study their models. • To understand the working and basic components of 2 stroke petrol and vapor compression refrigeration system through model study. • To understand basic components and working of water tube boiler through model study. • To learn the technique for determine of hardness and impact strength of a material. • To learn the technique for determine of compressive strength of a brick through UTM.						

Course Outcomes	
CO1	To understand the working and basic components of 4 stroke petrol engine and 4 stroke Diesel engine through study their models.
CO2	To understand the working and basic components of 2 stroke petrol and vapor compression refrigeration system through model study
CO3	To understand basic components and working of water tube boiler through model study.
CO4	To learn the technique for determine of hardness and impact strength of a material.
CO5	To learn the technique for determine of compressive strength of a brick through UTM.

Experiment No.	**Title of the Experiment**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Four Stroke Petrol Engine	To Study & Sketch the model of S.I. Engine (4 Stroke)	2	CO1
2	Four Stroke Diesel Engine	To Study & Sketch the model of C.I. Engine (4 Stroke).	2	CO1
3	Two Stroke Petrol Engine	To Study & Sketch the model of S.I. Engine (2 Stroke)	2	CO2
4	Vapor Compression	To Study & Sketch the model of Vapor Compression Refrigerators	2	CO2
5	Water Tube Boiler	To Study & Sketch the model of water tube boiler (Babcock & Wilcox)	2	CO3
6	Impact Testing	To determine the Impact Strength of Mild Steel using Izod Method	2	CO4
7	Hardness Testing	To determine the harness of a mild steel specimen by using hardness tester (Rockwell Hardness test)	2	CO4
8	UTM Testing	To learn the technique for determine of compressive strength of a brick through UTM.	2	CO5
e-Learning Source:				
https://www.vlab.co.in/				

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1		3			3	2		3	3	2	2
CO2	3	2	2	2		3			3	2		3	3	2	2
CO3	3	2	3	2		3			3	2		3	3	2	2
CO4	3	3	3	2		3			3	2		3	3	2	2
CO5	3	3	2	1		3			2	2		3	3	2	2

10- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2015-16							
Course Code	CS102	**Title of the Course**	COMPUTER PROGRAMMING LAB	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	0	0	2	1
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To learn the basic concepts and syntax of C programming. • To be able to develop logics which help them to create programs and applications using C language. • To learn the use of C libraries functions in C language. • To learn the file handling and basic memory allocation concepts in C language. • After learning the C programming, they can easily switch over to any other language.						

Course Outcomes	
CO1	Able to understand the basic concepts of C programming language and their implementation.
CO2	Able to design and develop various programming problems using C programming concepts.
CO3	Able to analyze and develop programs on pointers and functions.
CO4	Able to develop programs on different operations on arrays, matrices & strings.
CO5	Able to implement programs on structure, union & Dynamic memory allocation.

S. No.	**List of Experiments**	**Contact Hrs.**	**Mapped CO**
1	Write a Program to print any message.	2	1
2	Write a Program to print sum and multiply of two numbers.	2	1
3	Write a Program to enter the temperature in Celsius(c) then count it into Fahrenheit.	2	1
4	Write a Program to swap the number taking the help of third variable.	2	1
5	Write a Program to calculate the volume of box.	2	1
6	Write a Program to swap the number without taking the help of third variable.	2	2
7	Write a Program to check a year is leap year not.	2	2
8	Write a Program to print number is even or odd.	2	2
9	Write a Program to Print month of name using switch case.	2	2
10	Write a Program to print the no is positive or negative.	2	2
11	Write a Program to find the greater number enter by user.	2	2
12	Write a Program to find the greater number Input 3 No.	2	2
13	Write a Program to enter any no and check whether the given no is palindrome or not.	2	3
14	Write a Program to enter any no. and check whether the given no. is Armstrong or not.	2	3
15	Write a Program to Print Pattern * * * * * * * * * *	2	3
16	Write a Program to Print Pattern 1 2 3 4 1 2 3 1 2 1	2	3
17	Write a Program to Print Pattern 1 1 2 1 2 3 1 2 3 4	2	3
18	Write a program to find in C to design the report card of 5 subject according to the following condition if the total percentage are. >=35 and <45 IIIrdDiv >=45 and <60 IIndDiv >=60 IstDiv If any students score <35 in any of the subject display fail	2	3
19	Write a Program to create 2-D array or order M*N and insert the element and display it.	2	4
20	Write a Program to find the addition of two matrix of order M*N.	2	4
21	Write a Program to find the Transpose of the matrix.	2	4
22	Write a Program to swap two numbers Call by Value.	2	5
23	Write a Program to swap two number using function pointers.	2	5
24	WAP for structure of player Name, batting average and then name.	2	5

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	2		3		3						2	1	1
CO2	1	1	1	2	1		3						2	1	1
CO3	1	2	2	2			3						2	1	1
CO4	1	2	2	2			3						2	1	1
CO5	1	2	1				3						2	1	1

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	LN151	**Title of the Course**	Basic Professional Communication Lab	**L**	**T**	**P**	**C**
Year	**Ist**	**Semester**	I/II	**0**	**0**	**2**	**1**
Pre-Requisite	10+2	**Co-requisite**	**U.G. Program**				
Course Objectives	• The course aims to educate the students in both the artistry and utility of the English language for professional purposes through the study of language and literature. • The key component of the various types of professional communication is basically communication in the English language which is now a global language. • The Department of Languages caters to the needs of the students aspiring for training, expertise and excellence in professional communication with a marked emphasis on English for Specific/Special Purposes (ESP). • Students will be given new insights into the concepts of soft skills & professional communication to boost their confidence which will help them choose and build a better career which depends not only on the hard skills, but on one's soft skills & professional ethics also. • The course will help them overcome their fear & anxiety of public speaking & guide them to be a good & effective communicator whom people love to hear.						

Course Outcomes	
CO1	Students will be introduced to the basic understanding of communication and Professional Communication. Knowledge of Professional, cultural and cross-cultural communication will be imparted. Meaning and process of communication, verbal and nonverbal communication will be focused. Basic Understanding of communication and Professional/Business Communication will be provided. They will also learn & practice how to introduce oneself in professional setting & how to manage speaking anxiety. .
CO2	Corrections in basic English sounds and correct pronunciations will be practiced by various Listening exercises & word games to help them become better conversationalist.
CO3	Basic tools of communication and improvement in communicative competence. Improvement in communicative competence will be done by using various software applications, showing them cultural movies & involving them in exercises like small & situational talk.
CO4	Phonetic Alphabet and Phonetic Transcriptions will be taught & practiced to improve vocal clarity & pronunciation. Understanding the structural and functional grammar and basic structure of language.
CO5	Intonation & Stress will be practiced to make them learn how paralinguistic features dramatically affect meaning & how it can help one in becoming a persuasive & engaging speaker.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction**	Difference between Introduction and Description, SWOT Analysis	**6**	**CO 1**
2	**Software -I**	Listening exercises, Pronunciation improvement through self- testing, Vocabulary improvement through word games	**6**	**CO 2**
3	**Software – II**	Conversational skills, Exercises based on Language Skills/ Small talk, Cultural movies	**6**	**CO 3**
4	**Phonetics**	Phonetic Alphabet and Phonetic Transcriptions	**6**	**CO 4**
5	**Non-verbal communication**	Intonation and Stress	**6**	**CO 5**

Reference Books:

1. Gerson, Sharon J. *Technical Writing: Process and Product* (5th edition). Prentice Hall, 2005.
2. K. Floyd, *Interpersonal Communication: The Whole Story*. McGraw Hill, 2009.
3. Greenbaum, Sidney and Nelson Gerald, *An Introduction to English Grammar*. Routledge, 2009.
4. Swan, Michael, *Practical English Usage*. OUP, 2005.
5. Murphy, Raymond. *English Grammar in Use*. Cambridge University Press, 2019.
6. Kumar, Sanjay and Pushp Lata., Communication Skills. Oxford University Press, Oxford 2011.
7. Raman, Meenakshi, and Sangeeta Sharma. Technical Communication: Principals and Practice. Second Edition, Oxford University Press, 2012.
8. Gerson, Sharon J. *Technical Communication: Process and Product* (9th edition). Longman Pub., 2016.

e-Learning Source:

4. **https://ndl.iitkgp.ac.in./**
5. **https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=9RA537jM1m7VD3VCoav4lQ==**
6. **https://library.iul.ac.in/**

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	3	3	3	3	N.A.	N.A.	N.A.	N.A.	N.A.	3	3	3	3	3	N.A.
CO2	3	3	3	3	3	3	3	N.A.	N.A.	N.A.	N.A.	N.A.	3	3	3	3	3	N.A.
CO3	3	3	2	3	3	3	3	N.A.	N.A.	N.A.	N.A.	N.A.	3	3	3	3	3	N.A.
CO4	3	3	2	3	3	3	3	N.A.	N.A.	N.A.	N.A.	N.A.	3	3	3	3	3	N.A.
CO5	3	3	3	3	3	3	3	N.A.	N.A.	N.A.	N.A.	N.A.	3	3	3	3	3	N.A.

11- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Teaching and Learning methods	Flipped Classrooms, Concept Mapping, Information-Based Approach, Personal-Response Approach, Language-Based Approach, Paraphrastic Approach, Moral-Philosophical Approach and Stylistics Approach
List/Topics/Activities Planned that are beyond Syllabus	Information-Based Activities, Personal-Response Activities, Language-Based Activities, Periphrastic Activities, Moral-Philosophical Activities, and Stylistics Activities, Presentations, Small talk, Situational talk, role playing, Group Discussions, Assignments are used as a medium to work on cognitive development/growth.

Integral University, Lucknow

Effective from Session: 2023-2024							
Course Code	**EE103**	**Title of the Course**	**Basic Electrical Engg.**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	**1st**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Study of D.C Circuit Analysis and Network Theorems Circuit. • Study of AC fundamentals, Single-Phase AC Circuits. • Study of concept of Three Phase AC system, Circuits and measuring devices.\ • Study of concept of Magnetic Circuit and Transformer • Study of Electromechanical energy conversion devices: AC/ DC Machines.						

Course Outcomes	
CO1	Knowledge about the concept of D.C Circuit Analysis and Network Theorems Circuit.
CO2	Knowledge about Steady State Analysis of Single Phase AC Circuits AC fundamentals.
CO3	Knowledge about concept of Three Phase AC Circuits Three phase system and measuring devices
CO4	Knowledge about Magnetic Circuit and transformer
CO5	Knowledge about Electromechanical energy conversion devices: AC/ DC Machines

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**D.C Circuit Concept and its Analysis**	**Circuit concepts:** Active and passive elements, linear and nonlinear network, unilateral and bilateral elements, Series and Parallel Connections, Ohm's Law, Kirchhoff's Law, Loop analysis and nodal analysis **Network theorems:** Superposition theorem, Thevenin's theorem, Maximum Power Transfer theorem	8	CO1
2	**Domestic/Single Phase A.C. Circuit Analysis**	**AC fundamentals:** Average and effective value of Sinusoidal waveform, form factor and peak factor, Concept of phasors, Analysis of R, L and C Circuits, power factor, Apparent, Active and Reactive power, causes and problems of low power factor, resonance in series RLC circuit	8	CO2
3	**Commercial/ Industrial Three Phase AC Circuits and its measurement**	**Three phase system:** Its necessity and advantages, meaning of phase sequence, line and phase voltage/current relationship in star and delta connections **Measuring Instruments:** Types of instruments: construction and working principle of PMMC, MI type instruments, Electrodynamometer type wattmeter	8	CO3
4	**Transformer and its concept in Household/ Commercial application**	**Magnetic circuit:** Concepts, analogy between electric and magnetic circuit. **Single Phase Transformer:** Principle of operation, construction, emf equation, losses and efficiency	8	CO4
5	**House Hold/Industry oriented Electrical Machines**	**DC Machines:** Construction, Principle of operation and application **Single Phase Induction Motor:** Principle of operation and application **Three Phase Induction Motor:** Principle of operation and application **Three Phase Synchronous Machines:** Principle of operation and application	8	CO5

Reference Books:

1. V. Deltoro, "Principle of Electrical Engg.", PHI, 2nd edition, 2009
2. M. A. Mallick, Dr. I. Ashraf, "Fundamental of Electrical Engg.", CBS Publishers, 1st edition, 2010
3. A. Hussain, "Basic Electrical Engg.", Dhanpat Rai & Sons, 3rd edition, 2016
4. I J Nagrath, "Basic Electrical Engg.", TMH, 4th edition, 2019

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)															
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	1	1	3						3	3	3	2	3
CO2	3	3	3	2	1	1						2	3	2	2	3
CO3	3	2	1	1	2	2	3					3	2	2	2	3
CO4	3	2	2	2	3	3						2	3	2	2	3
CO5	3	1	1	1	1	2	1					2	3	2	2	3

4- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	**EE201**	**Title of the Course**	**LINEAR NETWORK AND SYSTEMS**	**L**	**T**	**P**	**C**
Year	**2nd**	**Semester**	**3rd**	3	1	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To acknowledge the students about basic laws and theorems • To analyze the theoretical and practical values of given circuit • To know about transient state and steady state • To acknowledge the students about stability, two port network and graph theory						

Course Outcomes	
CO1	For a given network, would be able to apply the knowledge of mathematics, science, and engineering to the analysis and design of electrical circuits, Identify, formulate, and solve engineering problems in the area electrical circuits & systems.
CO2	For a given system with dc and ac circuits, describe the different network theorems, would be able to apply, solve and verify the solutions using modern tools for lifelong learning like MATLAB.
CO3	For given a system with two port networks described in standard form, would be able to characterize, modeling, analyze, and verify the network in terms of all network parameters.
CO4	For given a system with RL, RC, and RLC circuits, would be able to understand, perform, formulate, and solve the differential equations for RL, RC, and RLC circuits and analyze the characteristics of the system.
CO5	For given a system description, would be able to explore and apply to alternate system description, and implement using basic blocks for network transfer function in s-domain and Two port networks.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Concept and AC Network theorems**	Kirchoff's law, Source transformation, loops analysis, node analysis, super mesh and super node. AC Network theorems: Superposition, Thevenin's, Norton's, Maximum power transfer theorem, Reciprocity, Substitution, Compensation, Millman's and Tellegen's theorem.	8	CO1
2	**Transient and steady state analysis**	Transient and steady state analysis for R-L, R-C and RLC circuits, Initial value and final theorem Use of Laplace transform in circuit analysis, Solution of differential equations. Lap lace transform of complex waveform.	8	CO2
3	**Network Synthesis**	Concept of poles and zeros, transfer function, Stability , Hurwitz Polynomial, Positive real function: Definitions and properties, Synthesis of RC, LC and RL Networks using Cauer and Foster I and II forms	8	CO3
4	**Two port networks**	Two port parameters, Inter-Conversion of two port Parameters, Interconnections of Two port networks, Reciprocity and Symmetry, T-pie transformation.	8	CO4
5	**Introduction to graph theory**	Definitions: Branch, Graphs, Tree, Co- tree, Path and Loop, Concept of Planner and non planner network, Incidence, Cut-set, Tie-set matrices for planer network. loop and nodal analysis.	8	CO5

Reference Books:

1. M.E.Van Valkenburg, Network Analysis, PHI
2. J.A.Edminister, Electric Circuits, Schaum Series, PHI
3. W.H. Hayt and Jack.E.Kammerly, Engineering Circuit Analysis, Tata Mc Graw Hill
4. A.Hussain, Network and Systems, Khanna publications

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	3	2	1		1	1	1		2	3	3	2	2		
CO2	3	2	3	3	2	2	1	2		1		1	3	3	3	2		
CO3	3	3	2	3	2	1							3	2	2	2		
CO4	3	2	2	3	1			1		1		1	3	3	2	2		
CO5	3	3	3	3	2	1		1		1			3	2	2	3		

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	EE 203	**Title of the Course**	Electro Mechanical Energy Conversion-I	1	0	4	**C**
Year	**2nd**	**Semester**	3rd	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives							

Course Outcomes	
CO1	Analyze magnetic circuit of rotating machines(AC and DC)
CO2	Develop the winding diagram of DC machines
CO3	Analyze the performance of DC machines
CO4	Analyze the performance of single phase transformer
CO5	Analyze the phase groupings of three phase transformers

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Principle of EMEC Introduction	Introduction,Energy in electromagnetic system,Flow of energy in electromechanical devices,Energy in magnetic field and co energy,Dynamics of electromechanical systems,Singly excited systems,Doubly Excited System	8	CO1
2	DC Machines	Construction,function of commutator,simplex lap and wave windings,emf and torque equations,armature reaction and commutation,remedial measures used for reducing commutation,D.C. generator characteristics	8	CO2
3	DC Machines and Special Machines	Characteristics of dc motors,testing of dc machines,Hopkinson's test and Swinburne test,dc motor starters,speed control and braking of dc motors **Special Motors**:Universal motor,PM dc machines,hysteresis motor,reluctance motor and stepper motor	8	CO3
4	Electrical Transformer -I	Principle of transformer action,construction of two winding transformer,equivalent circuit and phasor diagrams of ideal and real transformers,losses in transformers,Testing:open circuit,short circuit tests and Sumpner's test ,per unit system,Efficiency and voltage regulation	8	CO4
5	Electrical Transformer -II	Autotransformers:Introduction,comparison with two winding transformers,Three phase transformer:Construction,phase groupings,parallel operation,Phase transformation:Three phase to two phase,single phase and six phase ,applications of different types of transformer	8	CO5

Reference Books:

1. Electrical Machinery, Fitzgerald, Kingsley (McGraw Hill),6th Edition,2020
2. Electrical Machines and their Applications, J Hind Marsh,4th Edition,1984
3. Fundamental of Electrical Machines, B.R. Gupta & V. Singhal ,New Age International Pub.,2005
4. Electric Machinery and Transformers, I.L.Kosow, PHI,2007

e-Learning Source:

NPTEL

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2	1	1	3						3	3	2	1	3		
CO2	3	3	3	2	1	1						2	3	2	2	2		
CO3	3	2	1	1	2	2	3					3	2	2	1	3		
CO4	3	2	2	2	3	3						2	3	3	1	2		
CO5	3	1	1	1	1	2	1					2	3	1	2	2		

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	**EE205**	**Title of the Course**	**Solid State Devices & Circuit**	**L**	**T**	**P**	**C**
Year	**2nd**	**Semester**	**3rd**	3	1	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To analyze and designing concept of special purpose diodes and their industrial application. Understand the advancement in conductivity of semiconductors material. • To facilitate and understand the advancement in transistors like JFET, MOSFET, PMOS, NMOS, CMOS etc. and their various types' applications in Industries. Analyze the frequency response. • To develop and analyze the performance of small signal amplifiers and large signal amplifiers (Power amplifiers). • How to develop concept of feedback amplifiers, their different topologies and Implement it for various applications. To analyze their stability and their responses for different applications. • To analyze the design considerations of the active and passive filters. How to develop the various orders of filters and their industrial applications. To understand the constructional difference and working of various types of oscillators						

Course Outcomes	
CO1	Analyze and designing concept of special purpose diodes for different types of operation for industrial application purpose. Understand the advancement in conductivity of semiconductors material. Analysis the different regions in which BJT operates and their applications as a switches, amplifiers etc.
CO2	Understand the advancement in transistors like JFET, MOSFET, PMOS, NMOS, CMOS etc. and their various types' applications in Industries. Analyze the frequency response of these devices as different amplifier applications. To Understand how the gain of amplifier effected with frequency changes and their applications.
CO3	To develop and analyze the performance of small signal amplifiers and large signal amplifiers (Power amplifiers) . To understand and implement the various power amplifier in applications as transmitter and receiver in communication purpose.
CO4	Developing the concept of feedback amplifiers, their different topologies and Implement it for various applications. To analyze their stability and their responses for different applications.
CO5	To analyze the design considerations of the active and passive filters. How to develop the various orders of filters and their industrial applications. To understand the constructional difference and working of various types of oscillators. How the oscillators can be developed and their use in industries.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Diode and BJT**	Special Diodes, LED, Zener, Varactor, Schottky barrier, photo diode, and tunnel diode: their constructions and characteristics. Bipolar Junction Transistors, biasing of BJT, equivalent circuit, Transistor as a switch, cut off and saturation region, complete static characteristics of BJT, Darlington pair.	8	CO1
2	**FET and MOS**	Field Effect transistor: Structure and physical operation. Enhancement and depletion types MOSFET, Classification of MOS: NMOS, PMOS and CMOS I/V characteristics, Biasing of FET, Low and high frequency response of common source and common emitter configuration, Common base and Common gate cascade configurations, CC-CE cascade	8	CO2
3	**Amplifiers**	Small signal amplifiers: BJT and MOSFET, Frequency response improvement, Classification of amplifiers: Class A, Class B, Class C amplifiers, Power amplifiers, push pull amplifiers, DC amplifier, coupling methods.	8	CO3
4	**Feedback amplifiers**	Basic concept, General feedback structure, properties of negative feedback, four basic feedback topologies: series-series, series-shunt, shunt-series and shunt-shunt, determination of Loop gain, stability analysis, wave shaping circuits.	8	CO4
5	**Filters & Oscillators**	Active filters, Oscillators, condition for oscillation, Basic principles of sinusoidal oscillator, RC oscillators, Phase Shift oscillator, Wein bridge oscillator, Hartley and Colpitt's oscillator, Crystal Oscillator, Operational amplifier: Characteristics and application	8	CO5

Reference Books:

1. A.S. Sedra and K.C. Smith, "Microelectronic circuits", Oxford University Press (India). 2. B.P. Singh & R. Singh, Electronics Devices & Integrated Circuits, Pearson.

2. Millman, J. and Grabel, A., 'Microelectronics',/McGraw Hill.

3. Bell, David A,'Electronic Devices & Circuits',Prentice Hall (India) 4th Edition.

4. Nair, B. Somanathan, 'Electronics Devices & Applications',Prentice-Hall (India)

5. Neamen, Donald A., 'Electronic Circuit Analysis & Design',Tata McGraw Hill.

6. Sedra, 'Micro Electronics Circuits', Oxford University Press.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	2	2	3	3	1	1	1		2	2	2	2	2	2		
CO2	3	3	2	3	2	3	2						2	2	1	2		
CO3	3	2	3	2	2	2	1	1			1	1	2	3	2	2		
CO4	3	1	1	1	2	2	2						2	2	1	2		
CO5	3	1	1	1	2	2	2						2	3	1	3		

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2016-17							
Course Code	**EE207**	**Title of the Course**	**Fundamentals of EMFT**	**L**	**T**	**P**	**C**
Year	**2nd**	**Semester**	**3rd**	3	1	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To understand the students about Coordinates systems. To develop ability for analysis of three-dimensional space and obtain the solution of electromagnetic problems by Vector theorems and Operators. • To analyze the electrostatics problems by applying fundamental law's. • To realize and examine the magneto statics problems and response the behavior of magnetic fields in different magnetic materials • To recognize the concepts of Gauss Law and Maxwell equation by investigation in real time domain . To learn the Concepts of Displacement Current and Wave Propagation. • To execute the analysis of Guided Waves and transmission lines by various parameters and propagation constant						

Course Outcomes	
CO1	Given a physical quantity, students shall be able to represent this in vector and scalar form, identify type of system, apply vector algebra, and formulate the expression in different coordinates and solve using vector theorems.
CO2	Given a electrostatic problems of passive elements with sources, student shall be able to analyze and evaluate the problems using Gauss laws and Divergence theorem.
CO3	For a given magneto-static situation , student shall be able to generate its analytical response by Biot Savart's law and examine, analyze and evaluate the characteristics by Maxwell's Equation and Boundary Conditions
CO4	For a given Time varying function, students shall be able to identify its characteristics and for Wave Propagation , select suitable design of application of Maxwell's equation, develop various combination for Power by Pyonting Vector and explain the functions of its main components.
CO5	Given a Guided Waves and Transmission line, student shall be able to define its parameters, solve/ analyze, and modify its form

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Unit I**	Review of scalar and vector field, Co-ordinates systems and their transformation (Cartesian, cylindrical and spherical). Vector representation of surfaces, Del operator, Gradient of Scalar, Divergence of vector and Divergence theorem, Curl of vector and Stocks Theorem, Laplacian of Scalar.	8	CO1
2	**Electrostatic Fields**	Coulombs law and field Intensity, Electric flux density, Gauss's law and its application, Electric potential, Electric dipole and flux lines, Energy density. Introduction to conductors, Dielectrics polarization, Continuity equation, boundary conditions, Poisson's and Laplace's equation.	8	CO2
3	**Magneto-static Fields**	Biot-Savarts Law, Ampere's circuit law, Magnetic flux density, Magnetic scalar and vector potentials. Force due to magnetic fields, Lorentz-force equation, Magnetic torque and moment Magnetization in material, Boundary conditions, Energy density.	8	CO3
4	**Time-Varying Fields & Wave propagation**	Faraday"s law, displacement current, Maxwell's equation in integral and point form, Time varying potential, Time Harmonic Fields. Propagation of uniform plane waves in free space, dielectric and conductors, Pyonting theorem and power flow, Reflection of plane wave at Normal Incidence.	8	CO4
5	**Guided waves & Transmission line**	Introduction to guided waves, Rectangular waveguide. Transmission line parameter, Transmission line equations, Characteristic impedance, propagation constant (for lossless lines and Distortion-less lines), Input impedance, reflection coefficient, Standing wave ratio and Power. Open and short circuited lines.	8	CO5

Reference Books:

1. Elements of Electromagnetics- "M.N.O. Sadiku", oxford University Press
2. Electromagnetic waves and Radiating systems- E.C.Jorden, D.G.Balmein
3. Engineering Electromagnetics- "W.H.Hayt & J.A. Buck", TMH.
4. Electromagnetic- J.F.D.Kraus, R.C.Keith

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	1	2	1							2			2		
CO2	3	3	1	1	2								1	2	1	2		
CO3	3	3	1	1	2								1	3		2		
CO4	3	3	1	1	2							1	1	2		2		
CO5	3	3	2	2	2		1	1					2	3		3		

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	**EE 202**	**Title of the Course**	**Network Lab**	**L**	**T**	**P**	**C**
Year	**II**	**Semester**	III	**0**	**0**	**2**	**1**
Pre-Requisite	EE103	**Co-requisite**	NIL				
Course Objectives	• To acknowledge the students about basic laws & Theorems. • To analyze the theoretical & practical values of given circuit. • To know about transient state and steady state. • To acknowledge the students about stability, two-port network and graph theory.						

Course Outcomes	
CO1	Adopt, perform, analyze and implement the methods of measurement of electrical quantity of Theorems by Multimeter; contribute in related development
CO2	Adopt, perform, analyze and implement the methods of measurement of electrical quantity of RC , RL and RLC circuit byCRO; contribute in related development
CO3	Adopt, perform, analyze and implement the methods of two-port networks; contribute in related development
CO4	For given a system with RL, RC, and RLC circuits, would be able to understand, perform, formulate, and solve the differential equations for RL, RC, and RLC circuits and analyze the characteristics of the system.

Exp. No.	**Content of Experiment**	**Contact Hrs.**	**Mapped CO**
1	To verify Superposition theorem for dc network	2	1
2	To verify Thevenin's theorem for dc network	2	1
3	To verify Tellegen's theorem for dc network	2	1
4	To verify Maximum power transfer theorem for dc network	2	1
5	To study transient response of RC series circuit	2	2,4
6	To study frequency response of RLC series circuit	2	2,4
7	To determine the h-parameter of a port resistive network	2	3
8	To determine the z-parameter of a port resistive network	2	3
9	To determine the ABCD-parameter of a port resistive network	2	3
10	To study transient response of RLC series circuit	2	2,4

Reference Books:

1. M. E. Van Valkenburg, "Network Analysis", Chaukhamba Auriyantaliya Publication, 3rd Edition, 2010.
2. J. A. Edminister, "Electric Circuits", Schaum Outline Series, McGraw Hill Education; 5th edition, 2017.
3. W. H. Hayt and Jack E. Kammerly, "Engineering Circuit Analysis", McGraw Hill Education;Eighth edition, 2013.
4. A. Hussain, "Network and Systems", Khanna Book Publishing Co. (P) Ltd.; Second edition, 2019.

e-Learning Source:

PO-PSO	**Course Articulation Matrix: (Mapping of COs with POs and PSOs)**															
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	2	1		1	1	1		2	2	3	3	3
CO2	3	2	3	3	2	2	1	2		1		1	2	3	3	3
CO3	3	3	2	3	2	1							2	3	3	1
CO4	3	2	2	3	1			1				1	2	3	3	1

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	**EE 204**	**Title of the Course**	**Electromechanical Energy Conversion I Lab**	**L**	**T**	**P**	**C**
Year	**II**	**Semester**	III	**0**	**0**	**2**	**1**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To understand the operating principle of 3 point and 4 point starters and its applications • Knowledge of three phase transformers connections and protection system • Apply the knowledge to control the speed of DC motors • Apply the knowledge to obtain the magnetization characteristics of DC generator • Evaluate performance of DC machines on the basis of external characteristic						

Course Outcomes	
CO1	Analyze and implement different starters for starting DC motors
CO2	Analyse and apply the different speed control methods for DC motors
CO3	Analyse, test and determine the performance of single phase transformers
CO4	Apply the knowledge practically to determine the performance of DC machines under no load and loading condition

Exp. No.	**Title of the Unit**	**Content of Experiment**	**Contact Hrs.**	**Mapped CO**
1		To study three point starter and four point starter.	2	1
2		Open Circuit Characteristic of DC Shunt Generator.	2	4
3		Study of Three Phase Transformer.	2	3
4		Armature and Field control of a compound motor	2	2
5		Speed Control of a DC shunt motor by armature and field control.	2	2
6		To obtain load Characteristic of DC Series Generator.	2	4
7		Polarity test of Single Phase Transformer	2	3
8		Parallel operation of D.C Generators.	2	4

Reference Books:

1. V.Deltoro, “Principle of Electrical Engg.” PHI, 2009
2. M.A Mallick, Dr. I. Ashraf, “Fundamental of Electrical Engg,” CBS Publishers, 2010.
3. A. Hussain, “Basic Electrical Engg” Dhanpat Rai & sons, 2007
4. I J Nagrath,“Basic Electrical Engg” ,TMH, 2010.

e-Learning Source:

IIT -Roorkee Virtual Labs(https://www.vlab.co.in/participating-institute-iit-roorkee)

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	1	2	3									3	1	2	3			
CO2	1	2	3									3	1		3			
CO3	1	2	3									3	1		3			
CO4	1	2	3									3	1		3			

2- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2016-17							
Course Code	**EE 206**	**Title of the Course**	**SSDC Lab**	**L**	**T**	**P**	**C**
Year	**II**	**Semester**	III	**0**	**0**	**2**	**1**
Pre-Requisite		**Co-requisite**					
Course Objectives	To develop knowledge and application of fundamental electronic circuits and physical electronics of some key semiconductor devices, including design, construction and testing of experimental electronic circuits.						

Course Outcomes	
CO1	To designing concept of special purpose diodes for different types of operation for industrial application purpose. Understand the advancement in conductivity of semiconductors material. Analysis the different regions in which BJT operates and their applications as a switch, amplifiers etc..
CO2	Understand the advancement in transistors like JFET, MOSFET, PMOS, NMOS, CMOS etc. and their various types' of applications in Industries. Analyze the frequency response of these devices as different amplifier applications. To Understand how the gain of amplifier effected with frequency changes and their applications.
CO3	Developing the concept of feedback amplifiers, their different topologies and implement it for various applications. To analyze their stability and their responses for different applications.
CO4	To analyze the design considerations of the active and passive filters. How to develop the various orders of filters and their industrial applications. To understand the constructional difference and working of various types of oscillators. How the oscillators can be developed and their use in industries.

Exp. No.	**Title of the Unit**	**Content of Experiment**	**Contact Hrs.**	**Mapped CO**
1		Study of Clipping circuit and Clamping circuit	2	3
2		Study of LED (Red, Green, Yellow)	2	1
3		Study of single stage RC coupled transistor amplifier	2	2
4		Study of Emitter follower circuit and determine and determine a) Maximum signal handling capacity at 1 KHz at no load b) Plot frequency response at no load	2	1
5		Study of Wein's Bridge oscillator a) Determine the frequency of oscillation b) Determine the value of unknown capacitance C_x	2	4
6		Application of operation amplifier as Inverting, Non- Inverting, and unit gain amplifier(buffer).	2	3
7		Application of an operational amplifier as a differentiator and integrator. Plot frequency response	2	3
8		Study of MOSFET, plot V-I characteristics of N-MOS and P-MOS, find r_d,g_m and draw equivalent circuit.	2	2
9		Study of Clipping MOSFET as an amplifier (CS)	2	2
10		Study of Differential Amplifier using BJT	2	3

Reference Books:

1. VBell, David A/ "Electronic Devices & Circuits"/Prentice Hall (India) 4th Edition.
2. A.S. Sedra and K.C. Smith, "Microelectronic circuits", Oxford University Press (India).
3. Millman, J. and Grabel, A./" Microelectronics"/McGraw Hill.
4. Neamen, Donald A./ "Electronic Circuit Analysis & Design"/Tata McGraw Hill.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)															
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	2	3							2	2	2	3	1
CO2	3	3	1	2	3							2	2		1	1
CO3	3	1	1		3							2	2	3		1
CO4	3	1	1		3							2	2		3	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2016-17							
Course Code	**EE 208**	**Title of the Course**	**ELECTRICAL WORKSHOP LAB**	**L**	**T**	**P**	**C**
Year	**II**	**Semester**	III	**0**	**0**	**2**	**1**
Pre-Requisite		**Co-requisite**					
Course Objectives	• To understand and experiment with the measurement of Electronic Circuits and systems. • To understand and experiment with the Semiconductor devices and integrated circuits. • To understand and experiment with Transformer assembly. • To understand Printed Circuit Board and Preparation of PCB.						

Course Outcomes	
CO1	Adopt, perform, analyze and implement the methods of components of Electronic Circuits and systems.
CO2	Adopt, perform, analyze and implement the concepts of Transformer, Chokes, Potentiometer.
CO3	Adopt, perform, analyze the Semiconductor devices and integrated circuits.
CO4	Adopt, perform, and implement the designing of Printed Circuit Board (PCB) and related development

Exp. No.	**Title of the Unit**	**Content of Experiment**	**Contact Hrs.**	**Mapped CO**
1		To study the components of Electronic Circuits and systems. Types according to construction, rating and tolerance of Resistors, Capacitors, Inductors.	2	1
2		Study of Transformer, Chokes, Potentiometer, Switches and Rectifiers.	2	2
3		To study Semiconductor devices and integrated circuits: different rating and packages. Power Semiconductor devices and Heat Sinks.	2	3
4		To perform winding of Transformer, assembly of core and complete the transformer and also explain the various materials involved in it.	2	2
5		Preparation of Printed Circuit Board (PCB) and perform drilling on the PCB.	2	4
6		To perform soldering of components on the PCB and assembled circuit.	2	2
7		To perform Assembly of Electronic Circuits and Systems- Soldering and Communication Cable jointing. Bread Board Assembly of a regulated d.c. power supply.	2	3
8		Assembling of an unregulated DC power supply in a steel cabinet along with complete wiring.	2	4
9		Mini project (I): Stair case wiring.	2	4
10		Mini project (II): Core type transformer winding.	2	4

Reference Books:

1. R.P Singh Electrical Workshop, I.K. International Publishing House Pvt. Limited, 2005
2. A Textbook of Electrical Workshop Practices ,S.K. Kataria & Sons: 2019
3. P. S. Bimbhra Electrical Machinery : Dhanpat Rai & sons, 2007
4. I J Nagrath,"Basic Electrical Engg" ,TMH, 2010.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)															
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	2	3							2	2	2		3
CO2	3	3	1	2	3							2	2			3
CO3	3	1	1		3							2	2			3
CO4	3	1	1		3							2	2			3

Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2016-17							
Course Code	**EE209**	**Title of the Course**	**Electrical Measurement & Measuring Instruments**	**L**	**T**	**P**	**C**
Year	**2nd**	**Semester**	**4**	3	1	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	To understand the measurement system, measurement methods and errors, measurement of electrical quantities To understand three phase power measurement; working of thermocouple, electrostatic and rectifier type instruments; energy meter and instrument transformer To understand measurement of low, medium and high resistances, use of ac bridges and Q meter To understand use of ac potentiometer; measurement of speed, frequency and power factor To understand digital measurement of electrical quantities; CRO and its application						

Course Outcomes	
CO1	Adopt the methods of measurement, investigate the errors in measurement, analyze and rectify; perform analog measurement of electrical quantities; contribute in related development
CO2	Perform three phase power measurement; use thermocouple, electrostatic, rectifier type instruments, energy meter and instrument transformer for measurement; identify errors in energy meter and adopt remedies; adopt extension of instrument range using instrument transformer; contribute in related development
CO3	To perform measurement of low, medium and high resistances; perform measurement of inductance and capacitance using ac brides; adopt use of Q meter, contribute in related development
CO4	To adopt use of ac potentiometer; perform measurement of speed, frequency and power factor; contribute in related development
CO5	To perform digital measurement of electrical quantities; adopt application of CRO, dual trace and dual beam oscilloscopes; contribute in related development

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Unit I**	Philosophy of measurement: Methods of measurement, measurement system, classification of instrument system, characteristics of instrument and measurement system, error in measurement and its analysis. Analog measurement of electrical quantities: PMMC type Instruments, Moving Iron type Instruments, Electrodynamics type Instruments' three phase wattmeter, error and remedies in wattmeter.	8	CO1
2	**Unit II**	Power measurements in three phase system, Thermocouple, electrostatic and rectified type ammeter and voltmeter, Energy meter, error and remedies in energy meter. Instrument transformer and their application in the extension of instruments range.	8	CO2
3	**Unit III**	Measurement of parameter: Different methods of measurement of low, medium and high resistances, measurement of inductance and capacitance with the help of AC bridges, Q-meter.	8	CO3
4	**Unit IV**	AC Potentiometer: Polar type and co-ordinate type AC potentiometer, application of AC potentiometers in electrical measurement. Measurement of speed, frequency and power factor.	8	CO4
5	**Unit V**	Digital measurement of electrical quantities: concept of digital measurement, block diagram, study of digital voltmeter, frequency meter, Cathode ray oscilloscope: Basic CRO circuit (block diagram), cathode ray tube (CRT), and its components, application of CRO in measurement, Lissajous pattern, Dual trace and dual beam oscilloscopes.	8	CO5

Reference Books:

1. E.W. Golding & F.C. Widdis, "Electrical measurement & Measuring Instrument", A. W. Wheeler & Co. Pvt. Ltd. India.
2. A.K. Sawhney, "Electrical &Electronics Measurement & Instrument", Dhanpat Rai &Sons, India.
3. M.B. Stout ,"Basic Electrical Measurement" Prentice hall of India, India.
4. Forest K. Harries," Electrical Measurement", Willey Eastern Pvt. Ltd. India.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	1	2	3							2	2	2		3		
CO2	3	3	1	2	3							2	2			3		
CO3	3	1	1		3							2	2			3		
CO4	3	1	1		3							2	2			3		
CO5	3	1	1		3							2			2	3		

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	EE 211	**Title of the Course**	Electro Mechanical Energy Conversion-II	1	0	4	**C**
Year	**2nd**	**Semester**	4th	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Knowledge of principle of operation of three phase ac motors • Identify different ac motors on the basis of characteristics • Analyze different ac machines • To evaluate the performance of ac machines • Knowledge of parallel operation of ac generators						

Course Outcomes	
CO1	Knowledge of different types of three phase induction machines
CO2	Analyze the induction machines performance under loading condition
CO3	Evaluate the performance of single phase ac machines
CO4	Knowledge of three phase synchronous machines
CO5	Evaluate the performance of synchronous machines

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Three phase Induction Machine I**	Constructional features, Rotating magnetic field, Principle of operation Phasor diagram, equivalent circuit, torque and power equations, Torque- slip characteristics, no load & blocked rotor tests, efficiency, Induction generator & its applications. .	8	CO1
2	**Three phase Induction Machine- II**	Starting, Deep bar and double cage rotors, Cogging & Crawling, Speed Control (with and without EMF injection in rotor circuit).	8	CO2
3	**Single phase Induction Motor**	Double revolving field theory, Equivalent circuit, No load and blocked rotor tests, Starting methods, repulsion motor. AC Commutator Motors: Universal motor, single phase a.c.series compensated motor, stepper motors.	8	CO3
4	**Synchronous Machine I**	Constructional features, Armature winding, EMF Equation, Winding coefficients, equivalent circuit and Phasor diagram, Armature reaction, O. C. & S. C. tests, Voltage Regulation using Synchronous Impedance Method, MMF Method, Potier's Triangle Method, Parallel Operation of synchronous generators, operation on infinite bus, synchronizing power and torque co-efficient .	8	CO4
5	**Synchronous Machine II**	Two Reaction Theory, Power flow equations of cylindrical and salient pole machines, operating characteristics. Synchronous Motor: Starting methods, Effect of varying field current at different loads, V- Curves, Hunting & damping, synchronous condenser.	8	CO5

Reference Books:

1. D.P. Kothari & I.J. Nagrath , 'Electric Machines', Tata Mc Graw Hill,2004.
2. Ashfaq Hussain ,'Electric Machines', Dhanpat Rai & Company,2010.
3. Fitzerald ,A.E., Kingsley and S.D.Umans, 'Electric Machinery', MC Graw Hill,2014.
4. P.S.Bimbhra, 'Electrical Machinery', Khanna Publishers,2003

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	2	2	1								3	3	2	1	3		
CO2	3	2	3	1								2	3	2	2	2		
CO3	3	1	1	1								3	2	2	1	3		
CO4	3	2	2	2								2	3	3	1	2		
CO5	3	2	1	1			1					2	3	1	2	2		

3- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	**EE213**	**Title of the Course**	**Numerical Analysis and Applications**	**L**	**T**	**P**	**C**
Year	**2nd**	**Semester**	**4th**	3	1	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To provide suitable and effective methods called Numerical Methods, for obtaining approximate representative numerical results of the problems. • To solve problems in the field of applied mathematics, theoretical physics and engineering which requires computing of numerical results using certain raw data. • To solve complex mathematical problems using only simple arithmetic operations. The approach involves formulation of mathematical models of physical situations that can be solved with arithmetic operations. • To deal with various topics like finding roots of equations, solving systems of linear algebraic equations, interpolation and regression analysis, numerical integration & differentiation, solution of differential equation, boundary value problems, and solution of matrix problems. • To facilitate numerical computing.						

Course Outcomes	
CO1	Apply Numerical analysis which has enormous application in the field of Science and some fields of Engineering.
CO2	Describing and understanding of the several errors and approximation in numerical methods.
CO3	The explaining and understanding of the several available methods to solve the simultaneous equations by modern IT tools.
CO4	To solve problems in the field of applied mathematics, theoretical physics and engineering which requires computing of numerical results using certain raw data by using modern tools and follow the ethical rules.
CO5	To deal, communicate and environment sustainability with various topics like finding roots of equations, solving systems of linear algebraic equations, interpolation and regression analysis, numerical integration & differentiation, solution of differential equation, boundary value problems, and solution of matrix problems in the field of Engineering and modern life.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Errors and approximations**	Error definitions, accuracy and precision, round off and truncation errors **Roots of equations**- Solution of Algebraic and Transcendental equations, Newton- Raphson method, Secant method, Bisection method, Fixed Iteration method, Regula-Falsi method. **Finite differences**- Forward differences, Back ward differences, Central differences.	8	CO1
2	**Solutions of simultaneous linear algebraic equations**	Gauss elimination method, Gauss-Jordan method, Matrix inversion method, LU decomposition methods, iterative method: Gauss-Seidel, Jacobi's method	8	CO2
3	**Curve fitting**	Introduction, method of least square, fitting of a straight line by method of least square, change of origin and scale, normal equations for different form of curve. Interpolation with equal and unequal intervals: Newton's Gregory forward interpolation, Newton's Gregory backward interpolation, Newton's divided difference interpolation, Lagrange's interpolation	8	CO3
4	**Numerical differentiation**	Newton's Gregory forward interpolation formula to get derivatives, Newton's Gregory backward interpolation formula to get derivatives, Newton's divided difference interpolation formula to get derivatives, Lagrange's interpolation formula to get derivatives Numerical integration: Newton-cotes quadrature formula, Trapezoidal rule, Simpson's rule, Boole's rule, Weddle's rule	8	CO4
5	**Numerical solutions for ordinary differential equations**	Initial and Boundary value problems, Picard method of successes approximation, Taylor's series method, Euler's method, Modified Euler method, Runge-Kutta Method (First, second, third and fourth order)	8	CO5

Reference Books:

1. Josef Stoer and R. Bulirsch, "Introduction to Numerical Analysis" *Springer Science & Business Media*, ISBN 978-1-47575-592-3, Third Edition, 2013.

2.Lloyd N. Trefethen and David Bau III, "Numerical Linear Algebra", *Society of Industrial and Applied Mathematics*, ISBN: 978-0-898713-61-9, Illustrated edition, 1997.

3.C. T. Kelley, "Iterative Methods for Linear and Nonlinear Equations" , Frontiers in Applied Mathematics, Society for Industrial and Applied Mathematics, Philadelphia, ISBN:978-0-89871-352-7, 1995.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2		1									1		1	2		
CO2	3	2					1							2		2		
CO3	3	1										2		2		3		
CO4	3	2										1	2		2	2		
CO5	3	2					1							3		2		

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2016-17							
Course Code	**EE217**	**Title of the Course**	**Signal System Analysis**	**L**	**T**	**P**	**C**
Year	**2nd**	**Semester**	**4th**	3	1	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Demonstrate an understanding of the fundamental properties of linear systems • Uses of transform analysis and convolution, to analyze and predict the behavior of linear time invariant systems						

Course Outcomes	
CO1	Understand mathematical description and representation of continuous and discrete time signals and systems.
CO2	Develop input output relationship for linear time invariant system and understand the convolution operator for continuous and discrete time system.
CO3	Understand and resolve the signal in frequency domain using Fourier series and Fourier transforms.
CO4	Understand the limitations of Fourier transform and need for Laplace transform and develop the ability to analyze the system in s- domain
CO5	Analyze the discrete time signals and system using DTFT, DFT and Z

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Formalizing Signals**	Continuous-time/discrete-time, Periodic/non-periodic, even/odd, energy/power, deterministic/ random, Unit step, Unit ramp, Unit impulse, Sinusoid, complex exponential signals. **Signal Properties:** Periodicity, absolute integrability, determinism and stochastic character. **System properties:** Linearity, additivity and homogeneity, Scaling, shift invariance, causality. **Continuous and discrete time linear shift invariance system:** The impulse response and step response, convolution, input-output behavior.	8	CO1
2	**Fourier Transform Analysis**	Fourier series representation, Exponential and compact trigonometric form of Fourier series, Fourier symmetry, Fourier Transform, convolution/ multiplication and their effect in frequency domain, magnitude and phase response, Fourier domain duality, inverse Fourier transform, Application to circuit analysis, Dirichlet's condition.	8	CO2
3	**Discrete Fourier Transform**	Discrete time Fourier transform (DTFT), Discrete Fourier transform (DFT), Parsevals theorem, properties convergence, Sampling theorem and its implication, Reconstruction: Ideal interpolator, zero order hold, aliasing and its effect, Relation between continuous and discrete time system.	8	CO3
4	**Laplace Transform**	Laplace Transform for continuous time signals and systems: The notion of Eigen function of LSI system, region of convergence, system functions, poles and zeros of system functions and signals Convolution theorem, Laplace domain analysis, Waveform synthesis, solution to differential equation and system behavior.	8	CO4
5	**Z-Transform Analysis**	Z Transform for discrete time signal and system, Eigen function , region of convergence ,system function, poles and zeroes of system sequences, Z domain analysis, solution of difference equation, pulse transfer function	8	CO5

Reference Books:

1. S.H. Saeed, Faizan Arif Khan, "Basic System Analysis'' 2nd Edition, Katson Publishing Delhi.
2. A.V. Oppenhiem, A.S. Wilsky and I.T. young, "Signals & Systems", Prentice Hall, 1983
3. M E Van-Valkenberg; "Network Analysis", Prentice Hall of India.
4. B. P. Lathi, "Linear Systems & Signals" Oxford University Press, 2008.
5. I. J. Nagrath, S.N. Saran, R. Ranjan and S. Kumar, "Signals and Systems", Tata Mc. Graw Hill

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3		2		1			1	1		1	2			3		
CO2	3	3	2	2					1	1		1		2		2		
CO3	3	3	2	2		1			1	1		1			2	2		
CO4	3	3	2	2		1			1	1		1		2		2		
CO5	3	3	2	2		1	1		1	1		1		2		2		

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2016-17							
Course Code	**EE221 (DE-I)**	**Title of the Course**	**Electrical Engineering Materials**	**L**	**T**	**P**	**C**
Year	**2nd**	**Semester**	**4th**	3	1	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To apply the knowledge of material science engineering. • To understand the impact of realistic constraints such as economic, environmental, safety, reliability, manufacturability and sustainability. • To know the properties of conducting, insulating, dielectric and magnetic materials from electrical engineering point of view. • To realize the potential of semiconducting devices with their application. • To learn latest techniques, skills, and modern engineering tools necessary for electrical engineering fabrication processes.						

Course Outcomes	
CO1	To provide students with a thorough understanding of the electrical properties and characteristics of various materials used in the electrical appliances, devices, instruments and in the applications associated with generation, transmission and distribution of electric power.
CO2	To provide students with a thorough understanding of the electrical properties and characteristics of various materials used in the electrical appliances, devices, instruments and in the applications associated with generation, transmission and distribution of electric power.
CO3	To provide students with a moderate level understanding of the physics behind the semiconductors.
CO4	To provide students with a thorough understanding of the electrical properties and characteristics of various materials used in the electrical appliances , devices , instruments and in the applications associated with generation, transmission and distribution of electric power.
CO5	An understanding of the electrical engineering material science essential for them to work in different fabrication based industries and also motivate them to do innovative characterization based research while going for higher studies and also to work in R & D with scientific enthusiasm

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Classification of Materials**	Metals and alloys, polymers, conducting materials, characteristic of good conductors, commonly used conducting materials, smart materials, fuel cell, super alloys, memory alloys, degradation of materials, .	8	CO1
2	**Dielectrics, Insulating and Conducting Materials**	Dielectric strength, factor affecting strength, polarization, dielectric loss, Types of capacitor, Insulating & Dielectric Materials - Properties of insulating materials, classification of insulating materials, Piezoelectricity, Ferro electricity, Principle and Applications of Optical Fiber, Material for OH lines and UG cables, Fuse, soldering, Effect of temperature on transformer oil	8	CO2
3	**Semiconductors and their Applications**	Types of semiconductor, direct and indirect band gap, semiconductor application and advantages of semiconducting devices, photo conducting cell, Hall effect generator, MHD generator, LEDs, photodiode, Introduction to LCD .	8	CO3
4	**Magnetic Materials and their Applications**	Basic concepts and definitions, origin of magnetism, dia, Para, Ferro, anti Ferro, ferri magnetism, Curie Temperature, Hysteresis and its significance, soft and hard magnetic materials, ferrites, silicon steel, their properties and uses, magnetic resistance.	8	CO4
5	**Fabrication and Characterization of Materials**	Planar process,, lithography, etching, spin coating, sputtering, CVD, carbon nanotube, nanowires (synthesis, properties and applications), Material characterization techniques such as scanning electron microscopy, transmission electron microscopy, Scanning tunneling microscopy, atomic force microscopy, differential scanning calorimetry.	8	CO5

Reference Books:

1. A. J. Dekker, Electrical Engineering Materials, PHI.
2. C.S Indulkar & S.Thiruvegada, An introduction electrical Engg Materials, S. Chand & Co.
3. S.O Kasap, Principles of Electronic Materials & Devices, TMH
4. L.V Azaroff, Introduction to Solids, Mc Grow Hill Company
5. Charles Kittle, Quantum theory of Solids, John Wiley and Sons

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2		1									2	3		1		
CO2	3	2											3	3		1		
CO3	3	2		2								3	1	3		1		
CO4	2	1										3	2	2		2		
CO5	3		3									1	3	3				

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2023-24							
Course Code	**EE224 (DE-I)**	**Title of the Course**	**Illumination Engineering**	**L**	**T**	**P**	**C**
Year	**2nd**	**Semester**	**4th**	3	1	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	● To understand the basics of Illumination Engineering ● To understand the Illumination Systems ● To understand Indoor Lighting and Indoor Illumination Design ● To understand the Outdoor Lighting ● To understand the Modern Trends in Illumination						

Course Outcomes	
CO1	Understanding of Basics of Illumination Engineering
CO2	Understanding of Illumination Systems and its deign considerations
CO3	Understanding and implementation capability of indoor illumination design and scheme for residential, educational, medical and commercial installations
CO4	Understanding and implementation capability of outdoor illumination design and scheme
CO5	Understanding and implementation capability of Modern trends in Illumination such as LED, Organic Lighting System, Laser and Optic Fiber

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Illumination Engineering Basics**	Introduction- Necessity of illumination, Physical processes employed in the artificial sources. Eye and Vision, Laws of illumination, Light: Production, physics of generation, Photometry: Properties, quantification and measurement, Glare, Effect of Glare, Glare Indices, Color rendering index	8	CO1
2	**Illumination Systems**	Luminaries: Types, Design consideration, Standard (IEC598), Lighting fixtures, Construction and working of various types of Lamps, Electric control of Light sources using Ballast	8	CO2
3	**Indoor Lighting**	Zonal cavity method for general lighting design, Determination for zonal cavities and different shaped ceilings using COU (Coefficient of Utilization), Beam angles and polar diagram, Factors to be considered for design of indoor illumination scheme. Indoor Illumination Design: Residential, Educational institute, Hospitals and commercial Installation.	8	CO3
4	**Outdoor Lighting**	Factors consideration on designing of outdoor illumination scheme, Sports lighting, Flood lighting, Road lighting, Lighting for advertisement/Holding, Lighting calculation, Lighting applications.	8	CO4
5	**Modern Trends in Illumination**	LED Luminary designs, Intelligent LED fixtures, Natural lighting conductor, Organic lighting system, Laser characteristics, Features and applications, Optical fiber constructionas light guide, Features and applications.	8	CO5

Reference Books:

1. D.C. Pritchard Lighting, Routledge, 2018
2. H.Partab, "Art and Science of Electrical Energy" Dhanpat Rai & Sons, 2017
3. Craig Di Louie, "Advanced Lighting Controls: Energy Savings, Productivity, Technology and Applications", CRC Press, 2017
4. Kao Chen, "Energy Management in Illuminating Systems", Carlsons Consulting Engineers, San Diego, California, USA, CRC Press, 2009
5. Mark Stanley Rea, "IESNA Lighting Handbook", Illuminating Engineering Society of North America, 2000
6. S. M. Chaudhari, "Illumination Engineering", Tech Knowledge Publications, 2019

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																
PO-PS O CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO 1	3	3	1	2	3							2	3	2				
CO 2	3	3	1	2	3							2	3	2				
CO 3	3	1	1		3							2	3					
CO 4	3	1	1		3							2	3					
CO 5	3	1	1		3							2	3					

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2016-17							
Course Code	**EE 210**	**Title of the Course**	**Electrical Measurement Lab**	**L**	**T**	**P**	**C**
Year	**II**	**Semester**	IV	**0**	**0**	**2**	**1**
Pre-Requisite		**Co-requisite**					
Course Objectives	• To understand and experiment with the measurement of electrical quantity by DC Bridge • To understand and experiment with the measurement of electrical quantity by AC Bridge • To understand and experiment with the calibration of voltmeter • To understand and experiment with the calibration of ammeter						

Course Outcomes	
CO1	Adopt, perform, analyze and implement the methods of measurement of electrical quantity by DC Bridge; contribute in related development
CO2	Adopt, perform, analyze and implement the methods of measurement of electrical quantity by AC Bridge; contribute in related development
CO3	Adopt, perform, analyze and implement the methods of calibration of voltmeter; contribute in related development
CO4	Adopt, perform, analyze and implement the methods of calibration of ammeter; contribute in related development

Exp. No.	**Title of the Unit**	**Content of Experiment**	**Contact Hrs.**	**Mapped CO**
1		Measurement of Low Resistance by Kelvin's Double Bridge	2	1
2		Measurement of Self-Inductance by Maxwell's Bridge	2	2
3		Measurement of Self-Inductance by Hay's Bridge	2	2
4		Measurement of Capacitance by Schering's Bridge	2	2
5		Measurement of Capacitance by De Sauty's Bridge	2	2
6		Measurement of Frequency by Wein's Bridge	2	2
7		Calibration of Voltmeter	2	3
8		Calibration of Ammeter	2	4

Reference Books:

1. V.Deltoro, "Principle of Electrical Engg." PHI, 2009
2. M.A Mallick, Dr. I. Ashraf, "Fundamental of Electrical Engg," CBS Publishers, 2010.
3. A. Hussain, "Basic Electrical Engg" Dhanpat Rai & sons, 2007
4. I J Nagrath,"Basic Electrical Engg" ,TMH, 2010.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)															
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	2	3							2	2	2		3
CO2	3	3	1	2	3							2	2			3
CO3	3	1	1		3							2	2			3
CO4	3	1	1		3							2	2			3

2- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	**EE 212**	**Title of the Course**	**Electromechanical Energy Conversion II Lab**	**L**	**T**	**P**	**C**
Year	**II**	**Semester**	IV	**0**	**0**	**2**	**1**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To understand the operating principle of DOL and Star Delta Starters • Knowledge of single phase and three phase squirrel cage / slip ring induction motor • Apply the knowledge to control the speed of three phase AC motors • Evaluate performance of AC machines on the basis of external characteristic						

Course Outcomes	
CO1	Analyze and implement different starters for starting AC motors
CO2	Analyse and apply the different speed control methods for AC motors
CO3	Analyse, test and determine the performance of single phase induction motor
CO4	Apply the knowledge practically to determine the performance of AC machines under no load and loading condition

Exp. No.	**Title of the Unit**	**Content of Experiment**	**Contact Hrs.**	**Mapped CO**
1		To study DOL starter and star delta starter.	2	1
2		To study of slip ring induction motor.	2	1
3		To study of single phase capacitor start induction motor and observe (a) effect of capacitor on starting and running (b) reversal of direction of induction motor	2	3
4		To perform no load load test and block rotor test on a single phase inductionmotor	2	2
5		To study of synchronization of an alternator by two bright and one dark lamp method	2	4
6		To study speed control of 3 phase SCIM by voltage variation method	2	2
7		To study speed control of 3 phase SCIM by frequency variation method	2	3
8		Parallel operation of AC Generators.	2	4

Reference Books:

1. V.Deltoro, “Principle of Electrical Engg.” PHI, 2009
2. M.A Mallick, Dr. I. Ashraf, “Fundamental of Electrical Engg,” CBS Publishers, 2010.
3. A. Hussain, “Basic Electrical Engg” Dhanpat Rai & sons, 2007
4. I J Nagrath,“Basic Electrical Engg” ,TMH, 2010.

e-Learning Source:

IIT -Roorkee Virtual Labs(https://www.vlab.co.in/participating-institute-iit-roorkee)

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	1	2	3									3	1	2	3			
CO2	1	2	3									3	1		3			
CO3	1	2	3									3	1		3			
CO4	1	2	3									3	1		3			

4- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	**EE 214**	**Title of the Course**	**Numerical Analysis and Applications Lab**	**L**	**T**	**P**	**C**
Year	**II**	**Semester**	IV	**0**	**0**	**2**	**1**
Pre-Requisite		**Co-requisite**					
Course Objectives	• To provide suitable and effective methods called Numerical Methods, for obtaining approximate representative numerical results of the problems. • To solve problems in the field of applied mathematics, theoretical physics and engineering which requires computing of numerical results using certain raw data. • To solve complex mathematical problems using only simple arithmetic operations. The approach involves formulation of mathematical models of physical situations that can be solved with arithmetic operations. • To deal with various topics like finding roots of equations, solving systems of linear algebraic equations, interpolation and regression analysis, numerical integration & differentiation, solution of differential equation, boundary value problems, and solution of matrix problems.						

Course Outcomes	
CO1	Adopt, perform, analyze and implement the methods of simulation and programming of roots of equation by MATLAB; contribute in related development
CO2	Adopt, perform, analyze and implement the methods of simulation and programming of linear algebraic equation byMATLAB; contribute in related development
CO3	Adopt, perform, analyze and implement the methods of simulation and programming of numerical integration and differentiation by MATLAB; contribute in related development
CO4	Adopt, perform, analyze and implement the methods of simulation, programming and plot of equation by MATLAB;contribute in related development

Exp. No.	**Content of Experiment**	**Contact Hrs.**	**Mapped CO**
1	Study the overview of MATLAB and basic mathematical operations.	2	1
2	Find the determinants and inverse of given matrix [A] using MALAB.	2	1
3	Solve the linear algebraic equations by using MATLAB. 5x=3y-2z+10; 8y+4z=3x+20; 2x+4y-9z=9	2	2
4	Find the Eigen value & Eigen vectors of a given matrix A by using MATLAB.5x-3y+2z=10; -x+8y+4z=20; 2x+4y-9z=9	2	2
5	Plot the raw data to do fit linear curve and display the equation by using MATLAB. X= [5 10 20 50 100]Y= [15 33 53 140 301]	2	2,4
6	Solve the transcendental equation Sin $x=e^{x}$-5 & plot it by using MATLAB.	2	2,4
7	Evaluate function by Simpson's 1/3 rule using MATLAB.	2	3
8	Evaluate function by Simpson's 3/8 rule using MATLAB.	2	3
9	Find the roots & plot the error of the given $f(x) =x^{3}$-x-1 by Bisection method using MATLAB.	2	2,4
10	Find the root of the following equation's using Gauss Seidel Method.20x+y-2z=17; 3x+20y-z=18; 2x-3y+20z=25	2	2

Reference Books:

1. Josef Stoer and R. Bulirsch, "Introduction to Numerical Analysis" Springer Science & Business Media, ISBN 978-1-47575-592- 3, Third Edition, 2013.

2. Lloyd N. Trefethen and David Bau III, "Numerical Linear Algebra", Society of Industrial and Applied Mathematics, ISBN: 978-0-898713-61-9, Illustrated edition, 1997.

3. C. T. Kelley, "Iterative Methods for Linear and Nonlinear Equations" , Frontiers in Applied Mathematics, Society for Industrial and Applied Mathematics, Philadelphia, ISBN:978-0-89871-352-7, 1995.

e-Learning Source:

https://drive.google.com/drive/folders/1i52ieww0iq_YlYw7 7lX4q6RGHpP97B_u?usp=sharing

PO-PSO	**Course Articulation Matrix: (Mapping of COs with POs and PSOs)**															
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2									1	3	1	3
CO2	1	3	3	1	1								1	3	1	3
CO3	2	1	3	3	3	1			1		1	1	2	3	2	2
CO4	3	2	1	1	3	1		2	1		1	1	2	3	2	2

1-**Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	**EE 216**	**Title of the Course**	**Electrical Simulation Lab**	**L**	**T**	**P**	**C**
Year	**II**	**Semester**	IV	**0**	**0**	**2**	**1**
Pre-Requisite		**Co-requisite**					
Course Objectives	• Understanding Simulation Techniques: Students should grasp the fundamental concepts of simulation techniques used in electrical engineering. • Hands-on MATLAB Skills: Develop proficiency in using MATLAB for electrical simulations, including understanding the MATLAB environment, using built-in functions, creating scripts, and utilizing MATLAB's graphical capabilities. • Circuit Analysis and Design: Apply circuit analysis principles to solve complex electrical circuits involving resistors, capacitors, inductors, and operational amplifiers. Understand circuit behaviors, transient and steady-state responses, and frequency domain analysis. .						

Course Outcomes	
CO1	Adopt, perform, analyze and implement the methods of simulation techniques used in electrical engineering.by MATLAB.
CO2	Adopt, perform, analyze and implement the methods and develop proficiency in using MATLAB for electrical simulations, including understanding the MATLAB environment, using built-in functions, creating scripts byMATLAB
CO3	Adopt, perform, analyze and implement the methods of simulation and programming of numerical integration and differentiation by MATLAB; contribute in related development
CO4	Adopt, perform, analyze and implement the methods of simulation, and plot of electrical circuits by MATLAB;contribute in related development

Exp. No.	**Content of Experiment**	**Contact Hrs.**	**Mapped CO**
1	To Study the elements, Components & blocks used in MATLAB/Simulink.	2	1
2	To realize an active circuit using MATLAB Simulink and obtain current and voltage at each branches.	2	1
3	To realize a half wave rectifier circuit using MATLAB/Simulink.	2	2
4	To realize a full wave rectifier circuit using MATLAB/Simulink.	2	2
5	To verify Thevenin's theorem using MATLAB/Simulink.	2	2,4
6	To verify Norton's theorem using MATLAB/Simulink.	2	2,4
7	To verify Maximum power transfer theorem using MATLAB/Simulink.	2	3
8	To verify Superposition theorem using MATLAB/Simulink.	2	3
9	To study frequency response of series RLC circuit using MATLAB/Simulink.	2	2,4
10	Development and simulation of program using MATLAB/Simulink.	2	2

Reference Books:

1. Josef Stoer and R. Bulirsch, "Introduction to Numerical Analysis" Springer Science & Business Media, ISBN 978-1-47575-592- 3, Third Edition, 2013.

2. Lloyd N. Trefethen and David Bau III, "Numerical Linear Algebra", Society of Industrial and Applied Mathematics, ISBN: 978-0-898713-61-9, Illustrated edition, 1997.

3. C. T. Kelley, "Iterative Methods for Linear and Nonlinear Equations" , Frontiers in Applied Mathematics, Society for Industrial and Applied Mathematics, Philadelphia, ISBN:978-0-89871-352-7, 1995.

e-Learning Source:

https://drive.google.com/drive/folders/1i52ieww0iq_YlYw7 7lX4q6RGHpP97B_u?usp=sharing

PO-PSO	**Course Articulation Matrix: (Mapping of COs with POs and PSOs)**															
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2									1	3	1	3
CO2	1	3	3	1	1								1	3	1	3
CO3	2	1	3	3	3	1			1		1	1	2	3	2	2
CO4	3	2	1	1	3	1		2	1		1	1	2	3	2	2

1-**Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	**EE301**	**Title of the Course**	**CONTROL SYSTEMS**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**5th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To learn the concept of transfer function and mathematical modeling of systems. • To get the knowledge of first order and second order system. • To gain information of the system. • To evaluate the stability of the system using Nyquist stability criterion • To design the compensator and also study of state space analysis.						

Course Outcomes	
CO1	To learn the concept of transfer function and mathematical modeling of systems.
CO2	To get the knowledge of first order and second order system.
CO3	To gain information of the system.
CO4	To evaluate the stability of the system using Nyquist stability criterion
CO5	To design the compensator and also study of state space analysis.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Input/ Output Relationship**	Introduction to control system, Open and closed loop control system, Mathematical modeling of physical systems, Transfer function of electrical and mechanical system, Analogous systems, Block Diagram Reduction Algebra and signal flow graph, Mason's gain formula.	8	CO1
2	**Time Domain Analysis**	Time domain criteria; Test Signals; Transient and steady state response of first and second order feedback systems; Performance indices; Response analysis with proportional, Proportional- Derivative (PD) controller, Proportional-Integral (PI) controller and Proportional- Integral –Derivative (PID) controller.	8	CO2
3	**Stability, Algebraic Criteria and Frequency response Analysis**	Asymptotic and conditional stability, Routh Hurwitz criterion, Frequency response analysis, Correlation between time and frequency domain specifications, Resonant peak, Resonant frequency, Bandwidth, Cutoff frequency, Polar plots, Bode plots.	8	CO3
4	**Root Locus Technique and Stability in Frequency Domain**	The root locus concepts, Construction of root loci, Nyquist stability criterion, Relative stability, Gain margin, Phase margin, Constant M and N circles.	8	CO4
5	**Introduction to Design and State variable technique**	Design through compensation Techniques; Realization of Lag, Lead, And Lag-Lead compensation; Design of closed loop control system using root locus and bode plot compensation. Introduction to State variable analysis, State space representation, State equations, State transfer matrices, Controllability and observability.	8	CO5

Reference Books:

1 .B. C. Kuo, "Automatic Control system", Wiley, 9th Edition, 2014.

2. I. J. Nagrath & M. Gopal, "Control system Engineering", New Age International, 4th Edition, 2015.

3. K. Ogata, "Modern Control Engg.", PHI, 4th Edition, 2002.

4. S. K. Bhattacharya, "Control system Engg.", Pearson Education, 2nd Edition, 2008.

5. S. Hasan Saeed, "Automatic control system", Kataria and sons, New Delhi, 8th Edition, 2016

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	2		1									2	1	2			
CO2	3	2		1									3	2	3			
CO3	3	2										1	3	1	2			
CO4	1	3		2								1		2				
CO5	2	2	3									1	1		2			

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE303**	**Title of the Course**	**POWER ELECTRONICS**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**5th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To learn the concept of transfer function and mathematical modeling of systems. • To get the knowledge of first order and second order system. • To gain information of the system. • To evaluate the stability of the system using Nyquist stability criterion • To design the compensator and also study of state space analysis.						

Course Outcomes	
CO1	Understand and analyze the concept, design, technique, advancement and application of Bipolar junction transistor, Power Metal oxide semiconductor field effect transistor, Insulated gate bipolar junction transistor, operation of Silicon controlled rectifier (SCR), Firing circuits of Thyristor, Turn on methods of a Thyristor and Thyristor turn-off process.
CO2	Understand and analyze the concept, design, technique, advancement and application of Protection of Thyristor, Series and parallel operation of SCR, Gate turn off (GTO) thyristor. Understand and analyze the concept and knowledge advancement in Gate characteristic of an SCR, Dynamic characteristics of SCR, Two transistor analogy, Rating of an SCR
CO3	Understand and analyze the concept, design, technique, advancement and application of single phase half wave and full wave controlled rectifiers with different types of load, Effect of source impedance on the performance of full wave converter, Dual converter, three phase converters and cyclo-converters
CO4	Understand and analyze the concept, design, technique, advancement and application of Single phase bridge inverters (half and full wave), Pulse width modulation (PWM) inverters, Series inverter, Parallel inverter, Mc-Murray half bridge inverter, Three phase inverter.
CO5	Understand and analyze the concept, design, technique, advancement and application of choppers, chopper circuits, Multi quadrant choppers, Commutation of choppers, Switched mode power supplies.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Power Transistors I**	Classification of power transistors, Bipolar junction transistor (BJT), Power Metal oxide semiconductor field effect transistor (MOSFET), Insulated gate bipolar junction transistor (IGBT), Basic principle of operation of Silicon controlled rectifier (SCR), Voltage vs Current characteristics of SCR, Firing circuits of Thyristor, Turn on methods of a Thyristor, Thyristor turn-off process.	8	CO1
2	**Power Transistors II**	Protection of Thyristor, Gate characteristic of an SCR, Dynamic characteristics of SCR, Series and parallel operation of SCR, Two transistor analogy, Rating of an SCR, Gate turn off (GTO) thyristor.	8	CO2
3	**Controlled Rectifiers**	Controlled Rectifiers Analysis of single phase half wave and full wave controlled rectifiers with different types of load, Effect of source impedance on the performance of full wave converter, Dual converter, Introduction to three phase converters and cyclo-converters.	8	CO3
4	**Classification of inverters**	Classification of inverters, Single phase bridge inverters (half and full wave), Pulse width modulation (PWM) inverters, Series inverter, Parallel inverter, Mc-Murray half bridge inverter, Three phase inverter.	8	CO4
5	**Choppers**	Principle of choppers, Analysis of chopper circuits, Multi quadrant choppers, Commutation of choppers, Switched mode power supplies.	8	CO5

Reference Books:

1.M. H. Rashid, “Power Electronics: Devices, Circuits and applications”, Pearson, 4th edition, 2014.

2. J. M. Jacob, “Power Electronics: Principles and applications”, Thomson Press (India) Ltd; 1st edition, 2006.

3. Vedam Subramanium, “Power Electronics: Devices, Converters, Application”, New Age Int. (P) Ltd., 2nd edition, 2012.

4. Ned Mohan, “Power Electronics: Converters, Applications and Design”, Wiley, 3rd edition, 2002.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2	1	3	3	2	2	2	1	1	2	3	2	3			
CO2	3	3	2	1	3	3	2	2	2	1	1	2	3	2	2			
CO3	3	3	2	1	3	3	2	2	2	1	1	2	2	2	2			
CO4	3	3	2	1	3	3	2	2	2	1	1	2	2	3	2			
CO5	3	3	2	1	3	3	2	2	2	1	1	2	3	3	2			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	**EE305**	**Title of the Course**	**DIGITAL CIRCUITS AND SYSTEMS**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**5th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To understand number representation and conversion between different representation in digital electronic circuits. • Became familiar with the digital signal, positive and negative logic, Boolean algebra, logic gates, logical variables, the truth table, number systems, codes, and their conversion from one to others. • To analyze logic processes and implement logical operations using combinational logic circuits. • To understand competence in Combinational Logic Problem formulation. • To understand concepts of sequential circuits and to analyze sequential systems in terms of state machines. • To understand competence in analysis of synchronous and asynchronous sequential circuits. • To understand characteristics of memory and their classification. • To understand concept of Programmable Devices, PLA, PAL, PLD and FPGA and implement digital system. • To impart how to design Digital Circuits.						

Course Outcomes	
CO1	Convert different type of codes and number systems which are used in digital communication and computer systems. Develop a digital logic and apply it to solve real life problems.
CO2	Employ the codes and number systems converting circuits and Compare different types of logic families which are the basic unit of different types of logic gates in the domain of economy, performance and efficiency.
CO3	Analyze, design and implement combinational and sequential logic circuits.
CO4	Analyze different types of digital electronic circuit using various mapping and logical tools and know the techniques to prepare the most simplified circuit using various mapping and mathematical methods.
CO5	Design different types of with and without memory element digital electronic circuits for particular operation, within the realm of economic, performance, efficiency, user friendly and environmental constraints. Classify different semiconductor memories. Assess the nomenclature and technology in the area of memory devices and apply the memory devices in different types of digital circuits for real world application.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Number system, codes and Minimization Techniques**	Decimal, Binary, Hexadecimal, Octal Number systems and their Conversions, Arithmetic operations, subtraction using 1's and 2's compliment, Binary coded decimal, Excess-3 Codes, Gray Codes. Different types of Logic Gates and their implementation, Standard representation of logic functions- SOP and POS forms, simplification of switching functions- K Map..	8	CO1
2	**Logic Families**	Introduction to different logic families. RTL, DTL,TTL, MOS. TTL inverter – circuit description and operation, CMOS inverter – circuit description and operation, design of gates using TTL and CMOS circuits, Electrical characteristics of logic gates	8	CO2
3	**Combinational logic systems, Modules and their applications**	Basic logic operation and logic gates, Decoder, Encoder, Multiplexer, De-multiplexer, Parity circuits and comparators, Arithmetic modules- Half Adder, Full Adder, Half Subtractor, Full Subtractor, Carry Look Ahead Adder, Serial Adder, BCD adder	8	CO3
4	**Sequential logic systems, Modules and their applications**	Sequential Circuits- Latches and Flip-flops, Transition, Excitation table, Excitation maps and equations, Counters, Shift registers, 555 timers, Multivibrator.	8	CO4
5	**Memory and Programmable logic devices**	Read only memory, read/write memory- SRAM and DRAM. PLAs, PALs and their application, Sequential PLDs and their application, Introduction to Field Programming Gate Array.	8	CO5

Reference Books:

1. R.P. Jain, "Modern Digital Electronics", TMH, 4th Edition, 2010.
2. Morris Mano, "Digital Design", PHI, 3rd Edition, 2014.
3. R. J. Tocci, "Digital Systems", PHI, 4th Edition, 2016.
4. Malvino and Leach, "Digital principles and applications", TMH, 8th Edition, 2014.
5. J. M. Yarbrough, "Digital Logic-Application and Design", PWS Publishing, 5th Edition, 2006
6. B. S. Nai, " Digital Electronics and Logic Design", PHI, 7th Edition, 2012

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	2	2	2		1	2	1		1		1	2	2				
CO2	2	3		2	2	1	3			1	1	1	2	3	2			
CO3	3	3	3	2	2						1	1	3	3	3			
CO4	2	3	3	2		2	2			2	3		2	2	3			
CO5	1	2	2	2	2	2		3			1		2	2	2			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE307**	**Title of the Course**	**POWER SYSTEM I**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**5th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To get knowledge of Power System Components and Transmission Lines • To get knowledge of inductance and capacitance of Over-Head Transmission Lines • To attain knowledge of Corona and Overhead line Insulators • To study about Mechanical Design of transmission line and Insulated cables • To have the knowledge of Electrical Design of Transmission Line and Neutral grounding						

Course Outcomes	
CO1	Understand the Power System Components and Transmission Lines
CO2	Analyse the inductance and capacitance of Over-Head Transmission Lines
CO3	Understand the phenomenon of Corona and Overhead line Insulators
CO4	Having knowledge of Mechanical Design of transmission line and Insulated cables
CO5	Design Electrical Transmission Line and Neutral grounding

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Power System Components and Transmission Lines**	Single line Diagram of Power system, Brief description of Power System Elements: Synchronous machine, transformer, transmission line, busbar, circuit breaker and isolator. Different kinds of supply system and their comparison, Choice of transmission voltage. Transmission Line Configurations, Types of conductors, Resistance of line, Skin effect, Kelvin's law, Proximity effect.	8	CO1
2	**Head Transmission Lines**	Calculation of inductance and capacitance of single phase, three phase, single circuit and double circuit transmission lines; Representation and performance of short, medium and long transmission lines; Ferranti effect; Surge impedance loading.	8	CO2
3	**Corona and Overhead line Insulators**	Phenomenon of corona, Corona formation, Calculation of potential gradient, Corona loss, Factors affecting corona, Methods of reducing corona and interference, Electrostatic and electromagnetic interference with communication lines. Types of insulators and their applications, Potential distribution over a string of insulators, Methods of equalizing the potential, String efficiency.	8	CO3
4	**Mechanical Design of transmission line and Insulated cables**	Centenary curve, Calculation of sag & tension, Effects of wind and ice loading, Sag template. Type of cables and their construction, Dielectric stress, Grading of cables, Insulation resistance, Capacitance of single phase and three phase cables, Dielectric loss, Heating of cables.	8	CO4
5	**Electrical Design of Transmission Line and Neutral grounding**	Design consideration of Extra High Voltage (EHV) transmission lines, Choice of voltage, Number of circuits, Conductor configuration, Insulation design and selection of ground wires. Necessity of neutral grounding, Various methods of neutral grounding, Earthing transformer,Grounding practices.	8	CO5

Reference Books:

1. W. D. Stevenson, "Element of Power System Analysis", McGraw Hill, 4th revised edition,1982.
2. C. L. Wadhwa, "Electrical Power Systems", New age international Ltd , 6th Edition, 2010.
3. L.P. Singh, "Advance Power System Analysis & Dynamics", New Academic Science, 6th edition, 2012.
4. Ashfaq Hussain, "'Power System", CBS Publishers and Distributors, 5th Edition, 2010.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	2	1	1								1	2	1	2			
CO2	3	3		1								1	2	3	2			
CO3	3	3	1	2								1	2	3	2			
CO4	3	2	3				3		3	2	2	1	2	3	2			
CO5	3	1	3	2	2	2			3	2	2	2	2	3	2			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	**EE323**	**Title of the Course**	**PROCESS INSTRUMENTATION**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**5th**	3	1	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Knowledge of different process ant its characteristics. • Understanding of different control loops used in process. • Study and analysis of feedback control system and its applications. • Applications and design of multi-loop control system. • Concepts and design of multivariable control systems.						

Course Outcomes	
CO1	Know about different process ant its characteristics.
CO2	Understand different control loops used in process
CO3	Use feedback control system.
CO4	Design of multi-loop control system.
CO5	Design of multivariable control systems.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Process characteristics**	Incentives for process control; Process Variables types and selection criteria; Process degree of freedom; The period of Oscillation and Damping; Characteristics of physical System: Resistance, Capacitance and Combination of both; Elements of Process Dynamics; Types of processes: Dead time, single and multi-capacity, self-regulating and non self-regulating, interacting and non interacting, linear / non-linear; Selection of control action.	8	CO1
2	**Analysis of Control Loop**	Steady state gain; Process gain; Valve gain; Process time constant; Variable time Constant; Transmitter gain; Linearizing an equal percentage valve; Variable pressure drop; Analysis of Flow Control, Pressure Control, Liquid level Control, Temperature control; Single Line Process Controller: features, faceplate, functions; Multi Line Process Controller: features, faceplate, functions; Comparison of Single Line Process Controller and Multi Line Process Controller. Scaling: Types of scaling, Examples of scaling.	8	CO2
3	**Feedback Control**	Basic principles, Elements of the feedback Loop, Block Diagram, Control Performance Measures for Common Input Changes, Selection of Variables for Control Approach to Process Control. Factors in Controller Tuning; Determining Tuning Constants for Good Control Performance; Correlations for tuning Constants; Fine Tuning of the controller tuning Constants; The performance of feedback Systems; Practical Application of Feedback Control: Equipment Specification, Input Processing, Output Processing.	8	CO3
4	**Multi-Loop System**	Cascade control; Feed forward control; Feedback-feed forward control; Ratio control; Selective Control; Split range control: Basic principles, Design Criteria, Performance, Controller Algorithm and Tuning, Implementation issues, Examples and any special features of the individual loop and industrial applications	8	CO4
5	**Multivariable Control**	Concept of Multivariable Control, Interactions and its effects; Modeling and transfer functions; Influence of interaction on the possibility of feedback control; Important effects on multivariable system behavior; Relative Gain Array; Effect of interaction on stability and multi-loop control system; Multi-loop control performance through loop paring; Tuning; Enhancement through decoupling; Single loop enhancements.	8	CO5

Reference Books:

1. Donald P. Eckman, "Automatic Process Control", Wiley India Edition, Wiley India Pvt. Ltd, 2009
2. F. G. Shinskey, "Process control Systems", McGraw Hill, 4th Edition, 1996.
3. P. W. Murrill, "Fundamentals of Process Control Theory", International Society of Automation, 3rd Edition, 2012.
4. G. D. Considine, "Process Instrumentation and control Handbook", McGraw Hill, 5th Edition, 1993

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	1	1	1	1	3	1				1	3	3	3	1	3		
CO2	3	2	2	1	3	2	1				1	2	2	2	1	3		
CO3	3	2	2	1	3	3	3				1	3	1	1	2	2		
CO4	3	2	3	2	3	3	3				1	3	2	1	2	3		
CO5	3	3	3	3	3	3	2				1	3	3	3	3	3		

2- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session:							
Course Code	**EE 302**	**Title of the Course**	**Control system Lab**	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	V	**0**	**0**	**2**	**1**
Pre-Requisite		**Co-requisite**					
Course Objectives	• To learn of Transfer function and mathematical modeling of mechanical system. • To analyze the first order and second order system. • To evaluate the stability of the system using different frequency domain analysis tools • To design the compensator						

Course Outcomes	
CO1	To learn of Transfer function and mathematical modeling of mechanical system.
CO2	To analyse the first order and second order system.
CO3	To evaluate the stability of the system using different frequency domain analysis tools
CO4	To design the compensator and analyse the controller performance

Exp. No.	Title of the Unit	Content of Experiment	Contact Hrs.	Mapped CO
1	Input/ Output Relationship	To study the performance characteristics of a DC motor speed control system. 1) Open loop 2) Close loop	2	1
2	Time Domain Analysis	To study the steady state behavior of type 0 system.	2	2
3	Introduction to Compensator design	To study the phase lag network.	2	4
4	Controller performance analysis	To study the performance of various types of controller used to control the temperature of an oven. • ON /OFF control • Proportional control.	2	4
5	Time Domain Analysis	To study the Transient response of a series RLC circuit.	2	2
6	Input/ Output Relationship	To study and plot speed vs voltage characteristic of the dc servo motor.	2	1
7	Controller performance analysis	To simulate a DC motor (Armature control) system and draw the characteristic of the angular velocity using MATLAB/ SIMULINK	2	4
8	Frequency domain analysis	To check the sensitivity of the system using MATLAB at different gain for a given transfer function	2	3

Reference Books:

B. C. Kuo, “Automatic Control system”, Wiley, 9th Edition, 2014.

I. J. Nagrath & M. Gopal, “Control system Engineering”, New Age International, 4th Edition, 2015.

K. Ogata, “Modern Control Engg.”, PHI, 4th Edition, 2002.

S. K. Bhattacharya, “Control system Engg.”, Pearson Education, 2nd Edition, 2008.

e-Learning Source:

https://nptel.ac.in/courses/107106081

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3	1	2	3							2	2	2		3	3	3
CO2	2	3	1	2	3							2	2			3	3	3
CO3	3	1	3	2	3							2	2			3	3	1
CO4	3	1	1	1	3							2	2			3	3	1

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE 304**	**Title of the Course**	**Power Electronics lab**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	5th	**0**	**0**	**2**	**1**
Pre-Requisite		**Co-requisite**					
Course Objectives	• To understand and experiment of power electronics devices.. • To understand and experiment of SCR's. • To understand and experiment of solar cell. • To understand and experiment of the SMPS and chopper.						

Course Outcomes	
CO1	Adopt, perform, analyze and implement and to study the various components of power electronics devices.
CO2	Adopt, perform, analyze and implement and to study the RC and UJT trigger circuit of SCR..
CO3	Adopt, perform, analyze and implement and to study the working and characteristics of solar cell and basic components and circuit diagram of electronic fan regulator /light dimmer..
CO4	Adopt, perform, analyze and implement the to study the SMPS and plot the V-I characteristic and single phase bridge inverter.

Exp. No.	**Title of the Unit**	**Content of Experiment**	**Contact Hrs.**	**Mapped CO**
1		To study the various components of power electronics devices.	2	1
2		To study the characteristics ofSCR and plot the V-I graph.	2	1
3		To study the RC trigger circuit of SCR.	2	2
4		To study the UJT trigger circuit of SCR.	2	2
5		To study the phase control circuit of SCR.	2	2
6		To study the working and characteristics of sollar cell.	2	3
7		To study the basic components and circuit diagram of electanic fan regulator /light dimmer.	2	3
8		To study the SMPS and plot the V-I characteristic.	2	4
9		To study the single phase bridge inverter with resistive -capcitive load.	2	4
10		To study the fully controlled bridge rectifier with resistive load.	2	4
11		To study the SCR based step-down chopper with resistive load.	2	4

Reference Books:

1. M. H. Rashid, "Power Electronics: Devices, Circuits and applications", Pearson, 4th edition, 2014.
2. J. M. Jacob, "Power Electronics: Principles and applications", Thomson Press (India) Ltd; 1st edition, 2006.
3. Vedam Subramanium, "Power Electronics: Devices, Converters, Application", New Age Int. (P) Ltd., 2nd edition, 2012.
4. Ned Mohan, "Power Electronics: Converters, Applications and Design", Wiley, 3rd edition, 2002.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)															
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	2	3							2	2	2		3
CO2	3	3	1	2	3							2	2			3
CO3	3	1	1		3							2	2			3
CO4	3	1	1		3							2	2			3

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE306**	**Title of the Course**	**Digital Circuits & Systems Lab**	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	5^{th}	**0**	**0**	**2**	**1**
Pre-Requisite		**Co-requisite**	EE305				
Course Objectives	• To acquire the basic knowledge of digital logic levels and application of knowledge to understand digital electronics circuits. • To know the concepts of Combinational circuits. • To understand the concepts of flip-flops, registers and counters						

Course Outcomes	
CO1	Identify relevant information to supplement to the Digital Circuits & Systems (EE305) course.
CO2	Define different types of logic gates, identify their ICs, verify their truth table. Derive adder, subtractor, encoder, decoder, and counters using logic gates.
CO3	Illustrate realization of Boolean expression in SOP form and design it using logic gates.
CO4	Design and implement combinational logic circuits.
CO5	Design and implement sequential logic circuits.

Exp. No.	**Topic of Experiment**	**Content of Experiment**	**Contact Hrs.**	**Mapped CO**
1	Realization of gate	Realize OR, NOR, XOR, XNOR gates using NAND gate and verify its truth table.	2	1,2
2	Comparator	Design and study of 1-bit Magnitude Comparator.	2	1,2,4
3	Code converter	Design and test a CODE converter from decimal number to binary number. Use diode and LED's. Measure voltage drops across the diodes, LED's and resistor R. Find the current flowing through LED.	2	1,2,4
4	Adder Subtractor	Assemble the half Adder circuit using X-OR and AND gates. Verify the truth table for Half Adder. Using two Half Adder and an OR gate, assemble Full Adder circuit, verify truth table. Express sum and carry with all the minterms in minimization possible.	2	1,2,3,4
5		Study and verify 4-bit adder / subtractor circuit using IC7483 and IC7486.	2	1,2
6	Encoder/ Decoder	Use a BCD to 7 segment decoder 0-9 digits. Study the 7 segment LED display. Is it common anode or common cathode type? What is a suitable value or R for bright display of digit? Design a BCD to 7 segment decoder using NAND gates. Use K-Maps and don't care terms to implement the design with minimum number of gates.	2	1,2,3,4
7	XOR gate IC-module (7486)	Verify the truth table and record voltage levels. Design a 3-input X-OR gate using 2-input X-OR gate. Obtain its truth table. $F_1 = A \oplus B \oplus C$ Design a 3-input X-NOR gate using 7486 &7402. Obtain its truth table. $F_2 = A \odot B \odot C$ Find expressions of F1 and F2 as Sum of product (SOP) and compare F_1 and F_2.	2	1,2,4
8	Flip Flops	Design and test J-K Master-Slave F/F IC 74LS76. Make special observation of edge triggering present and clear. Make and test D-F/F and T-F/F and verify its truth table.	2	1,5
9	Counter	Design MOD-10 Counter using Master – Slave F/F (7476) and logic gates (7400 & 7408). Verify truth table.	2	1,3,5
10	Register	Design of Shift Registers.	2	1,5

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)															
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3		3	3	2				2	1	3	2	1	
CO2	2	2	1		2		1					1	3	1	1	
CO3	2	2	2	2		1				1	1	1	1	2	1	
CO4	3	2	2	3				2	1	2		2	2	3	1	
CO5	2	3	3	2				1	2	2		2	2	3	1	

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session:							
Course Code	**EE324**	**Title of the Course**	**Process Instrumentation Lab**	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	5^{th}	**0**	**0**	**2**	**1**
Pre-Requisite		**Co-requisite**					
Course Objectives	• To understand and experiment with the IC Temperature Sensor (LM335). • To understand the characteristics of Platinum RTD • To understand the characteristics of K Type Thermocouple. • To understand the characteristics of NTC Thermistor. • To understand the working principle of Strain gauge.						

Course Outcomes	
CO1	Adopt, perform, analyze the use of IC Temperature Sensor (LM335).
CO2	Adopt, perform, analyze the use of Platinum RTD.
CO3	Adopt, perform, analyze the use of K type Thermocouple
CO4	Adopt, perform, analyze the use of NTC Thermister
CO5	Adopt, perform, analyze the use of Strain Gauge

Exp. No.	**Title of the Unit**	**Content of Experiment**	**Contact Hrs.**	**Mapped CO**
1		To study the characteristics of IC Temperature Sensor (LM335).	2	1
2		To study the characteristics of platinum RTD	2	2
3		To study the characteristics of K Type Thermocouple.	2	3
4		To study the characteristics of NTC Thermistor.	2	4
5		To study the Temperature controlled Alarm System using 1NTC.	2	4
6		To study the Temperature controlled Alarm System using 2NTC.	2	4
7		To study the characteristics of NTC Bridge circuit.	2	4
8		To understand the working principle of Strain gauge.	2	5

Reference Books:

1. Donald P. Eckman, “Automatic Process Control”, Wiley India Edition, Wiley India Pvt. Ltd, 2009
2. F. G. Shinskey, “Process control Systems”, McGraw Hill, 4^{th} Edition, 1996.
3. P. W. Murrill, “Fundamentals of Process Control Theory”, International Society of Automation, 3^{rd} Edition, 2012.
4. G. D. Considine, “Process Instrumentation and control Handbook”, McGraw Hill, 5^{th} Edition, 1993

e-Learning Source:

	Course Articulation Matrix: (Mapping of Cos with Pos and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3	1	2	3							2	2	2		3	3	3
CO2	3	3	1	2	3							2	2			3	3	3
CO3	3	1	1		3							2	2			3	3	1
CO4	3	2	2		3							2	2			3	3	1
CO5	3											3	3			3		2

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE311**	**Title of the Course**	**POWER SYSTEM II**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**6th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Representing elements of a power system including generators, transmission lines, and transformers. • Understand the functioning of a synchronous machine and represent it with simple models. • Perform Fault analysis for a balanced three-phase power system . • Analyze multi-node power systems using an admittance matrix or impedance matrix representation of the power system factor the admittance matrix to obtain a solution of the network voltages. • Understand the formulation of the power flow problem, and have the ability to cast any given system in this framework. • Solve power flow problems by the application of Newton method & Gauss seidel. • Perform Steady-state analysis for a balanced three-phase power system,Reflection and Transmission of travelling waves under different line loadings • Protection of equipments and line against travelling waves						

Course Outcomes	
CO1	Representation of Elements in Electric Power System in Per-Unit system and Analysis of Symmetrical faults.
CO2	Analysis of Unsymmetrical faults.
CO3	Understanding the formulation of the power flow problem and to cast any given system in this framework
CO4	Understanding the concept of steady state and transient stability.
CO5	Need of Protection of equipments and line against travelling waves.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Representation of Power System Components**	Synchronous machines, Transformers, Transmission lines, Single line diagram, Impedance and reactance diagram, Per unit System, Transient in R-L series circuit. Symmetrical fault analysis: Calculation of 3-phase short circuit current and reactance of synchronous machine, internal voltage of loaded machines under transient conditions	8	CO1
2	**Symmetrical components**	Symmetrical Components of unbalanced phasors, power in terms of symmetrical components, sequence impedances and sequence networks. Unsymmetrical faults: Analysis of single line to ground fault, line-to-line fault and Double Line to ground fault on an unloaded generators and power system network with and without fault impedance. Formation of Zbus using singular transformation and algorithm	8	CO2
3	**Load Flows**	Introduction, bus classifications, nodal admittance matrix, development of load flow equations, load flow solution using Gauss Siedel and Newton-Raphson method, approximation to N-R method, line flow equations and fast decoupled method.	8	CO3
4	**Power System Stability**	Stability, Stability limit, Steady state stability study, derivation of Swing equation, transient stability studies by equal area criterion and step-by-step method, Factors affecting steady state & transient stability and methods of improvement.	8	CO4
5	**Traveling Waves**	Wave equation for uniform transmission lines, velocity of propagation, surge impedance, reflection and transmission of traveling waves under different line loadings, Protection of equipments and line against traveling waves.	8	CO5

Reference Books:

1.W.D. Stevenson, Jr. " Elements of Power System Analysis", Mc Graw Hill 4th edition

2. C.L. Wadhwa, "Electrical Power System", New Age International, 2009

3. Chakraborthy, Soni,Gupta & Bhatnagar, "Power System Engineering", Dhanpat Rai & Co. ,2008

4. T.K Nagsarkar & M.S. Sukhija, "Power System Analysis" Oxford University Press, 2007.

5. Hadi Sadat; "Power System Analysis", Tata McGraw Hill. 2nd Edition, 2002.

6.D.Das, " Electrical Power Systems" New Age International, 2006.

7. P.S.R. Murthy " Power System Analysis" B.S. Publications,2007.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2								2	2	3	3	2			
CO2	3	3	2	2	2								3	3	2			
CO3	3	3	1	2	2							2	3	3	2			
CO4	3	2	3	2	3					2	2		3	2	1			
CO5	3	3	3			2	1				2	2	3	2	1			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	**EE313**	**Title of the Course**	**Microprocessor and Peripheral Devices**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**6th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Knowledge of I/O devices and memories • To get knowledge of architecture of 8085 and 8086 • To attain knowledge of different instruction set of 8085 and 8086 • To study about different types of Programmable Peripheral Interface • To have the knowledge of analog to digital and digital to analog converter chips						

Course Outcomes	
CO1	Understand the basics of microprocessor
CO2	Understand the architecture of 8085 and 8086
CO3	Knowledge of instruction set of 8085 and 8086
CO4	Knowledge of programmable peripheral interface
CO5	Knowledge of analog to digital and digital to analog converter

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Introduction of Microcomputer System**	Introduction of Microcomputer System: General definition of minicomputer, microprocessors,CPU, I/O devices, clock, memory, bus architecture, tri-state logic, address bus, data bus and control bus. Semiconductor Memories: Development of semiconductor memory, internal structure and decoding,memory read and writes timing diagrams, ROM, RAM.	8	CO1
2	**Architecture of Microprocessors**	Architecture of Microprocessors: Introduction of Intel 8085 and 8086 microprocessor, Pindescription and their internal architecture. Introduction of Intel 80386. Operation and Control of Microprocessor: Timing and control unit, memory read/write machinecycles, I/O read/write machine cycles, interrupt acknowledge machine cycle.	8	CO2
3	**Instruction Set**	Instruction Set: Addressing modes- Data transfer, arithmetic, logical, branch, stack andmachine control groups of instruction set, unspecified flags and instructions. Assembly Language Programming, Assembler directives, Subroutines..	8	CO3
4	**Interfacing**	Interfacing: Interfacing of memory chips, Interfacing of I/O devices, I/O addressing-I/Omapped and memory mapped I/O schemes, 8257(DMA Controller), 8259(Interrupt priority Control), 8253/8254 Programmable timer/counter with modes of operation. Interrupts: Interrupt structure of 8085 microprocessor.	8	CO4
5	**Programmable Peripheral Interface**	Programmable Peripheral Interface: Intel 8255, pin configuration, internal structure of a portbit, modes of operation, bit SET/RESET feature, ADC and DAC chips and their interfacing. Programmable Interval Timer: Intel 8253, pin configuration, internal block diagram of counter andmodes of operation, counter read methods.	8	CO5

Reference Books:

1.B.Ram, "Fundamentals of Microprocessor and Microcomputer", Dhanpat Rai Publication, 4th Edition.2008

2. M.Rafiquzzaman, "Microprocessors and Applications", John Wiley & Sons ,2008

3. Hall D.V.,"Microprocessor and Interfacing-Programming and Hardware", 2nd Ed., Tata McGraw-Hill Publishing Company Limited, reprinted 2008

4. Gaonkar R.S.,"Microprocessor Architecture,Programming and Applications", 6th Ed., Penram International, 2013.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3			1	1	1	1					3	3	3	2			
CO2	3	2	2	2	2	1						3	3	3	2			
CO3	3	2	2	2	2	1						3	3	2	2			
CO4	3	2	2	2	2	1	1					3	2	2	2			
CO5	3	1	1	1	1	1	1					3	3	2	2			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE325**	**Title of the Course**	**CONVENTIONAL & CAD OF ELECTRICAL MACHINES**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**6th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To develop knowledge on principles of design of static and rotating machines. • To understand the fundamental concepts of design process, designing of main dimensions & cooling systems of transformers and rotating machine. • To provide advanced knowledge and understanding about the construction and design of the electrical machines. • To provide the basis and the methodologies to correct a design of the electrical machines (transformers, rotating (AC machines and DC machines). • To understand the design optimization of the electrical machine for industrial, automotive and aerospace applications.						

Course Outcomes	
CO1	Student understands the basic concept of design, limitations faced in the designing process, and classification & importance of Insulating materials.
CO2	Student is able to understand the design concepts of transformers and know about how to design the core, yoke & windings.
CO3	Upon completing the course, student is able to understand the factors affecting the size of rotating machines and design of core & armature in DC machines along with selection of frame size.
CO4	Student is able to understand the rotor design of Induction motor and field system design of Synchronous machines & DC machines along with problem solving techniques related to design.
CO5	Student understands the importance of Computer aided design and different approaches based on their applications along with the concept of optimization.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Basic Considerations**	Basic concept of design, Limitation in design, Standardization, Modern trends in design and manufacturing techniques, Classification of insulating materials. Calculation of total magnetomotive force (m.m.f) and magnetizing current.	8	CO1
2	**Transformer Design**	Output equation; Design of core, yoke and windings; Overall dimensions; Computation of no load current to voltage regulation; Efficiency and cooling system designs	8	CO2
3	**Design of rotating machines I**	Output equations of rotating machines, Specific electric and magnetic loadings, Factors affecting size of rotating machines, Separation of main dimensions, Selection of frame size, core and armature design of dc machines.	8	CO3
4	**Design of rotating machines II**	Core and armature design of 3-phase ac machines, Rotor design of three phase induction motors, Design of field system of Direct Current (DC) machine and synchronous machines, Estimation of performance from design data.	8	CO4
5	**Computer Aided Design**	Philosophy of computer aided design, advantages and limitations; Computer aided design approaches analysis; Synthesis and hybrid methods; Concept of optimization and its general procedure; Flow charts and 'c' based computer programs for the design of transformer, DC machine, three phase induction and synchronous machines.	8	CO5

Reference Books:

1. A. K. Sawhney, **"**A Course in Electrical Machine Design**",** Dhanpat Rai & Sons, 6th Edition, 2006.
2. K.G. Upadhyay, "Conventional and Computer Aided Design of Electrical Machines",Galgotia Publications, 1st edition, 2004
3. M.G. Say, "The Performance and Design of AC Machines", Pitman & Sons, 2nd Edition 1952
4. A.E. Clayton and N.N. Hancock, "The Performance and Design of D.C. Machines", Pitman &Sons.
5. S.K. Sen, "Principle of Electrical Machine Design with Computer Programming", Oxford and IBM Publications

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2									3	3	3	2			
CO2	3	3	2	2	2						2		3	3	2			
CO3	3	3	1	2	2						2	2						
CO4	3	2	3	2	3					2	2							
CO5	2	2	2			2	2											

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE333**	**Title of the Course**	**ADVANCED CONTROL SYSTEMS**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**6th**	**3**	**1**	**0**	**4**
Pre-Requisite	Control System EE301/EE301	**Co-requisite**	None				
Course Objectives	• To learn the concept of state space analysis of continuous system. • To get the knowledge of state equations, controllability and observability • To design the state observer and controller using pole-placement approach • To gain information on non-linear control system • To evaluate the stability of the system using Lyapunov's stability analysis						

Course Outcomes	
CO1	Students will be able to understand different state model of a system, and have the knowledge to find its solution.
CO2	Students will be industry ready by analysis of controllability and observability of the dissimilar system.
CO3	Students will be industry ready by designing the State observer and controller using pole- placement approach
CO4	Students will be able to understand nonlinear system models, and analyse its stability.
CO5	Students will be able to analyse system's stability using Lyapunov stability analysis.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**State Space Analysis of Continuous System**	Introduction, Concept of state, Sate variable description, State space representation, state variable representation of continuous system, Conversion of state variable models to transfer function and vice-versa.	8	CO1
2	**State Equations, Controllability and Observability**	Characteristic equation, state transition matrix, Solution of state equations, Concept of controllability and Observability, Controllable, observable and diagonal canonical form.	8	CO2
3	**Pole-Placement Design and State observer**	Concept of pole-placement, Stability improvement by state Feedback, State regulator design, design of state observers and controller.	8	CO3
4	**Non-linear Control System**	Types and characteristics of non-linearity, phenomena related to non-linear systems. Phase plane analysis, types of phase portraits, singular points, construction of phase portraits, system analysis by phase-plane method, describing function and its application to system analysis.	8	CO4
5	**Lyapunov's Stability analysis**	Concept of Lyapunov's stability, Stability of equilibrium state, asymptotic stability, Lyapunov's stability theorems for continuous systems, methods of generating Lyapunov's function for continuous system, Stability analysis of non-linear system.	8	CO5

Reference Books:

1.M.Gopal, "Digital Control and State variable Methods", Tata Mc Graw Hill, 4th Edition, 2015

2.Ajit K.Madal, "Introduction to Control Engineering: Modelling, Analysis and Design" New Age International, 5th Edition, 2013.

3.K. Ogata, "Modern Control Engg.", PHI, 4th Edition, 2002.

4.S. K. Bhattacharya, "Control system Engg.", Pearson Education, 2nd Edition, 2008.

5.B.N. Sarkar "Advanced control system" PHI Learning Pvt. Ltd., 2013.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	2		1										2	2			
CO2	3	2													3			
CO3	3	2		2								1	2	2				
CO4	1	2		3								1			2			
CO5	2	2	3		2							1		2				

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2023-24							
Course Code	**EE335**	**Title of the Course**	**INDUSTRIAL AUTOMATION**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**6th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To improve quality, and reduce human involvement and possibility of human error. • To raise the level of safety for personnel • To reduce the work piece damage caused by manual handling						

Course Outcomes	
CO1	Understand and analyze the concept, design, technique, advancement and application of Automatic Control, Proportional- Integral-derivative (PID) Control and their Tuning, Feed-forward and Ratio Control, Time Delay Systems and Inverse Response Systems
CO2	Understand and analyze the concept, design, technique, advancement and application of Different types of controllers, Single loop and Multi loop controllers, Sequential and Programmable controllers, Architecture, Functional blocks, Programming of PLC: Relay logic and Ladder logic, Communication Networks for PLC, PLC based control of processes- Computer control of liquid level system, heat exchanger; Smart sensors.
CO3	Understand and analyze the concept, design, technique, advancement and application of Functional requirements and Components. General features, Functions and Applications, Benefits. Configurations of SCADA, Remote Terminal Unit Connections. Human Machine interface.
CO4	Understand and analyze the concept, design, technique, advancement and application of Different architectures, Local control unit, Operator Interface, Engineering interface, Study of any one DCS available in market, Factors to be considered in selecting DCS
CO5	Understand and analyze the concept, design, technique, advancement and application of robot, Asimov's Laws of robotics, construction and configuration, Pick and Place robot, Industry 4.0

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Industrial Automation Systems	Introduction, Architecture, Introduction to Automatic Control, Proportional- Integral-derivative (PID) Control and their Tuning, Feed-forward and Ratio Control, Time Delay Systems and Inverse Response Systems.	8	CO1
2	Controllers	Different types of controllers, Single loop and Multi loop controllers, Sequential and Programmable controllers, Architecture, Functional blocks, Programming of PLC: Relay logic and Ladder logic, Communication Networks for PLC, PLC based control of processes- Computer control of liquid level system, heat exchanger; Smart sensors	8	CO2
3	Supervisory Control and Data Acquisition (SCADA)	Introduction, Functional requirements and Components. General features, Functions and Applications, Benefits. Configurations of SCADA, Remote Terminal Unit Connections. Human Machine interface.	8	CO3
4	Distributed Control System (DCS):	Evolution, Different architectures, Local control unit, Operator Interface, Engineering interface, Study of any one DCS available in market, Factors to be considered in selecting DCS	8	CO4
5	Industrial Automation using Robots	Robotics: Introduction, Definition of a robot, Asimov's Laws of robotics, Robot terminology, Basic construction and configuration, Pick and Place robot, Introduction to Industry 4.0	8	CO5

Reference Books:

1. Seborg, D.E., Edgar, T.F. and Mellichamp, TF Edgar, FJ Doyle III, "Process dynamics and control", Wiley, 3rd edition 2010
2. Smith, C.A. and Corripio, A.B. "Principles and practice of automatic process control", Wiley, 3rd edition, 1997
3. Johnson, C.D. "Process control instrumentation technology," Prentice-Hall, 8th edition, 2008
4. 4. Kalsi, H.S., "Electronic Instrumentation", McGraw Hill, 3rd edition, 2010
5. Anjana, R., "Industrial Automation", Technical Publications, 1st Edition, 2022

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3	1	2	3							2	3	2	3			
CO2	3	3	1	2	3							2	3	2	3			
CO3	3	1	1	2	3							2	3	2	3			
CO4	3	1	1	2	3							2	3	2	3			
CO5	3	1	1	2	3							2	3	2	3			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE343**	**Title of the Course**	**RENEAWABLE ENERGY TECHNOLOGY**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**6th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To Give the basic knowledge of Nonconventional energy Resources sources. • To make aware the students about alternate resources of energy. • To provide the knowledge of decentralized energy supply to agriculture, industry, commercial and House-hold sector.						

Course Outcomes	
CO1	Given an energy systems and quantifying energy students shall be able to represent this in comparison to various conventional Fossil fuels, identify type of system, apply vector algebra, and formulate the Remedies & alternatives for fossil fuels.
CO2	Given a Modelling of Solar Energy with sources, student shall be able to analyse theory of solar cells, solar radiation, solar characteristics and limitations.
CO3	For a Wind Energy Systems, student shall be able to generate its analytical response and resource assessment, analyse and evaluate the characteristics by Power Conversion Technologies.
CO4	For a given Hydro power, students shall be able to identify its characteristics and for Generation and Distribution, select suitable design of application of Mini and Micro-hydel Power with various combination for System
CO5	Given a Nuclear Energy system, student shall be able to define its fuel enrichment, different types of nuclear reactors, nuclear waste disposal, solve/ analyse, and modify Integrated Energy systems

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Introduction**	Introduction to energy systems and resources; Energy: sustainability & the environment, Quantifying energy & energy arithmetic, Electricity - a primer, Fossil fuels - past, present & future, Remedies & alternatives for fossil fuels, Energy efficiency and conservation, Introduction to renewable energy, availability, classification, relative merits and demerits.	8	CO1
2	**Source of Energy**	Sun as Source of Energy, Availability of Solar Energy, Nature of Solar Energy, Solar Energy & Environment. Various Methods of using solar energy –Photo thermal, Photovoltaic, Present & Future Scope of Solar energy. Theory of solar cells, solar radiation, solar characteristics, limitations, solar thermal power plants, Solar Photovoltaic systems.	8	CO2
3	**Basics & Power Analysis**	Basics & Power Analysis, Wind resource assessment, Power Conversion Technologies and applications, Wind Power estimation techniques, Principles of Aerodynamics of wind turbine blade, classification of rotors, wind characteristics, Performance and limitations, various aspects of wind turbine design.	8	CO3
4	**Hydro power**	Hydro power: Potential, Hydropower Generation and Distribution, Mini and Micro hydel Power (MHP) Generation: Classification of hydel plants, Concept of micro hydel, merits, MHP plants: Components, design and layout, Turbines, efficiency, Status in India.	8	CO4
5	**Nuclear Energy**	Potential of Nuclear Energy, Nuclear Energy Technologies – Fuel enrichment, Different Types of Nuclear Reactors, Nuclear Waste Disposal and Nuclear Fusion. Hybrid energy systems - Integrated Energy systems, Diesel-PV, wind-diesel power, wind conventional grid, wind-Photovoltaic system.	8	CO5

Reference Books:

1.B.H Khan, "Non-Conventional Energy Resources" Tata Mc Graw-Hill Pvt. Ltd., 2nd Edition,2009.

2.G.D.Rai, "Non-Conventional Energy Resources" Khanna Publishers, 4th Edition, 2000.

3.Freris, L.L. "Wind and Solar Power Systems" Prentice Hall, London, 1999

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2										2	2	2			
CO2	3	3	2	2	2								2	2	2			
CO3	3	3	1									2	3	2	2			
CO4	3	3	3	2	3					2	2		2	3	2			
CO5	3	3	3			2	1						2	2	2			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE345**	**Title of the Course**	**POWER ELECTRONICS BASED CONVERTERS DESIGN**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**6th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Knowledge and concept of non-isolated DC-DC converters. • Analysis & Design of Isolated Converters. • Knowledge and concept of AC Regulators. • Analysis & Design of Self Driven Inverters. • Designing of Soft switching Converters						

Course Outcomes	
CO1	Know about the concept of non-isolated DC-DC converters.
CO2	Analyze & Design Isolated Converters.
CO3	Know about concept of AC Regulators.
CO4	Analyze & Design Self Driven Inverters.
CO5	Design Soft switching Converters.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Unit I**	Limitations of Linear power supplies; Switched Mode Power Conversion; Analysis & Design of Non-isolated DC-DC Converters: Buck, Boost, Buck-boost operations in CCM and DCM.	8	CO1
2	**Unit II**	Analysis & Design of Isolated Converters: Forward, Push-Pull, Half Bridge, Full Bridge, Flyback, Cuk, SEPIC, High-Boost Topologies.	8	CO2
3	**Unit III**	Review of AC Regulators and Cyclo-converters; Voltage control and Harmonic minimization in inverters, square wave operation; Multilevel Inverter.	8	CO3
4	**Unit IV**	Analysis & Design of Self Driven Inverters, Driven Inverter, Quasi-Square Wave Inverter;PWM, PWM with Harmonic Elimination; Matrix Converter.	8	CO4
5	**Unit V**	Soft switching Converters - Switching loss, hard switching, soft switching; Resonant Converter, basic principles of ZVS, ZCS, and ZVZCS.	8	CO5

Reference Books:

1. Ned Mohan, Tore M, Undelnad, William P, Robbins (3rd Edition), "Power Electronics:Converters, Applications and Design," Wiley 2002.
2. L. Umanand, Power Electronics - Essentials and Applications; Wiley India Pvt. Ltd
3. P.C Sen.,' Modern Power Electronics ', Wheeler publishing Co, First Edition, New Delhi,1998.
4. M H Rashid, Power Electronics - Circuits, Devices and Applications; PHI, New Delhi.
5. Philip T Krein: Elements of Power Electronics; published by Oxford University Press.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	1	1	1	1	3	1					3		2	2			
CO2	3	2	3	1	3	3	1					3	2	3	2			
CO3	3	1	1	1	1	3	1					3		3	2			
CO4	3	2	3	1	3	3	1					3	2	3				
CO5	3	2	3	3	3	3	2					2	2	2	2			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE347**	**Title of the Course**	**Modeling and Dynamic Analysis of Electrical Machines**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**6th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To develop knowledge of the concept of magnets • To understand the advance concepts of DC machine • To provide advance knowledge of reference frame theory • To understand the advance concepts of Induction machine • To understand advance concepts of Synchronous machine						

Course Outcomes	
CO1	Student understands the basic concept of magnets and electromechanical conversion
CO2	Student is able to understand the characteristics of DC machines
CO3	Student is able to understand the concept of reference frame theory
CO4	Student is able to understand the reference frame concept in induction machines
CO5	Student understands the importance of performance of synchronous machine under different conditions

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Basics of Magnetic Circuits**	Flux, mmf, reluctance - self, leakage, magnetizing and mutual inductances; Analysis of magnetic circuits with airgap; Analysis of singly excited electromechanical system with linear magnetics; Basic Fundamentals of electromechanical energy conversion.	8	CO1
2	**Analysis of DC Machines**	Voltage & Torque Equations; Dynamic Characteristics of Permanent Magnet & Shunt DC Motors; Time-Domain Block Diagrams & State Equations; Solution of Dynamic Characteristics by Laplace Transformation.	8	CO2
3	**Reference Frame Theory**	Introduction; Equations of Transformation; Commonly Used Reference Frame – Rotor, Stator, Synchronous & Arbitrary; Transformation between reference frames..	8	CO3
4	**Analysis of Induction Machines**	Voltage & Torque Equations; Commonly used reference frames; Analysis of Steady-State operation; Free Acceleration Characteristics; Dynamics Performance under load change.	8	CO4
5	**Analysis of the Synchronous Machines**	Voltage & Torque Equations ; Analysis of steady state operation and Dynamic performance; Response under short circuit conditions, sub transient, transient and steady state conditions.	8	CO5

Reference Books:

1. Paul C. Krause, “Analysis of Electrical Machinery & Drive System”, Wiley India, 2nd Edition 2010
2. R.Krishnan, “Electric Motor Drives, Modeling, Analysis, & Control”, Prentice Hall, 2nd Edition 2002
3. P.S. Bimbhra, “Generalised Theory of Electrical Machines”, Khanna Publishers
4. B.K.Bose, “Modern Power Electronics & AC Drives”, Prentice Hall, 2015
5. O'Simmons and Kelly, "Introduction to Generalized Machine Theory", 1968
6. Bernard Adkins, “The General theory of electrical Machines”, Chapman & hall ltd
7. I.P. Kopylov, “Mathematical Models of Electric Machines”, Mir Publisher

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2									3	3	3	2			
CO2	3	3	2	2	2						2		3	3	2			
CO3	3	3	1	2	2						2	2						
CO4	3	2	3	2	3					2	2							
CO5	2	2	2			2	2											

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE351**	**Title of the Course**	**SENSOR AND INSTRUMENTATION**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**6th**	**2**	**1**	**0**	**3**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• different types of sensors and transducers used in Industries • DSP,ADC,DAC,S/H circuit. • Analyse the instuments on the basis of accuracy,precision and resolution						

Course Outcomes	
CO1	Knowledge of different types of sensors and transducers used in Industries
CO2	Knowledge of DSP,ADC,DAC,S/H circuit. Measurement of flux and hysteresis of magnetic specimen
CO3	Analyse the instuments on the basis of accuracy,precision and resolution
CO4	Knowledge of different telemetry systems

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Sensors & Transducer**	Definition, Classification & Characterization, Displacement Sensors: Potentiometric, LVDT & Optical Encoder; Accelerometers: Mass & Piezoelectric; Strain Gauges: Wire & Semiconductor; Pressure Sensor: LVDT based Diaphragm & Piezoelectric, Temperature Sensor: Thermocouple, RTD, & Liquid in Glass; Flow Sensor: Ultrasonic, Electromagnetic, Laser & Thermal; Level Sensor: Ultrasonic & Capacitive; Proximity Sensor, Concept of Smart Sensors.	8	CO1
2	**Digital Processing of Analog Signal**	Analog Multiplexer Circuit, S/H Circuit, ADC, DAC, Convolution, Digital Filtering. Magnetic Measurement: Ballistic Galvanometer, flux meter, determination of hysteresis loop, Measurement of iron losses.	8	CO2
3	**Instrumentation System**	Flow, Pressure, and Temperature Measurement; Measurement Errors: Gross errors and systematic errors, Absolute and relative errors, Accuracy, Precision, Resolution and Significant figures.	8	CO3
4	**Data Transmission and Telemetry**	Telemetry System and its Classification, Voltage, Current and Position Telemetry Systems, Frequency Modulation Telemetry.	8	CO4

Reference Books:

1. Arun K. Ghosh "Introduction to measurements and Instrumentation, PHI, 4th Edition 2012.
2. David A. Bell "Electronic Instrumentation & measurement" 3rd Edition 2013, Oxford University Press.
3. DVS Murthy "Transducers and Instrumentation, PHI 2nd Edition 2013
4. D Patranabis "Sensors and Transducers" PHI 2nd Edition 2013.
5. Ranjan CS (et.al) "Instrumentation and Device Systems" PHI.
6. A.K.Sawhney and Puneet Sawhney," A Course in Electrical and Electronics Measurement and Instrumentation," Dhanpat Rai & Co.Pvt Ltd.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1					3	1				3	2		2	3	1			
CO2	1		2		3								3	2	1			
CO3		3	2		1								3	2	1			
CO4						1			2	3			3	3	1			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE353**	**Title of the Course**	**POWER STATION PRACTICE**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**6th**	**2**	**1**	**0**	**3**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To get the knowledge of electric energy demand and growth in India • To get the detailed knowledge of Thermal Power Plant. • To get the detailed knowledge of Hydro Power Plant. • To get the knowledge of Nuclear, Gas and Diesel Power Plant. • To have the knowledge of Power Plant Economics and Tariffs • To have the knowledge of Economic Operation of Power Systems						

Course Outcomes	
CO1	Understand the Electric energy demand and growth, Thermal Power Plant and Hydro Electric Power Plant
CO2	Understand the Nuclear Power Plant, Gas Turbine Plant and Diesel Power Plants
CO3	Having knowledge of Power Plant Economics and Tariffs
CO4	Having knowledge of Economic Operation of Power Systems

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Thermal Power Plant and Hydro Power Plant**	Introduction: Electric energy demand and growth in India, electric energy sources. Thermal Power Plant: Site selection, general layout and operation of plant, detailed description and use of different parts. Hydro Electric Power Plant: Classification, location and site selection, detailed description of various components, general layout and operation of Plants; brief description of impulse, reaction, Kaplan and Francis turbines; advantages & disadvantages; hydro-potential in India.	8	CO1
2	**Nuclear, Gas and Diesel Power Plant**	Nuclear Power Plant: Location, site selection, general layout and operation of plant. Brief description of different types of reactors, Moderator material, fissile materials, control of nuclear reactors, disposal of nuclear waste material, shielding. Gas Turbine Plant: Operational principle of gas turbine plant & its efficiency, fuels, open and closed-cycle plants, regeneration, inter-cooling and reheating, role and applications. Diesel Power Plants: Diesel power plant layout, components & their functions, its performance, role and applications.	8	CO2
3	**Power Plant Economics and Tariffs**	Load curve, load duration curve, different factors related to plants and consumers, Cost of electrical energy, depreciation, generation cost, effect of Load factor on unit cost. Fixed and operating cost of different plants, Objectives and forms of Tariff, Causes and effects of low power factor, advantages of power factor improvement, different methods for power factor improvements.	8	CO3
4	**Economic Operation of Power Systems**	Characteristics of steam and hydro power plants, Constraints in operation, Economic load scheduling of thermal power plants, Neglecting and considering transmission Losses, Penalty factor, loss coefficients, Incremental transmission loss, Hydrothermal Scheduling.	8	CO4

Reference Books:

1. B.R. Gupta, "Generation of Electrical Energy", S. Chand Publication, 7th Edition ,2017
2. Soni, Gupta & Bhatnagar, "A text book on Power System Engineering", Dhanpat Rai & Co.
3. W. D. Stevenson, "Elements of Power System Analysis", McGraw Hill,4th Edition, 1982.
4. S. L. Uppal, "Electrical Power", Khanna Publishers, 15th Edition,2009

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	2	1	1								1	2	1	2			
CO2	3	3		1								1	2	3	2			
CO3	3	3	1	2								1	2	3	2			
CO4	3	2	3				3		3	2	2	1	2	3	2			
CO5	3	1	3	2	2	2			3	2	2	2	2	3	2			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session:							
Course Code	**EE 334**	**Title of the Course**	**Advanced Control system Lab**	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	VI	**0**	**0**	**2**	**1**
Pre-Requisite		**Co-requisite**					
Course Objectives	• To learn of Transfer function and mathematical modeling of mechanical system. • To analyze the first order and second order system. • To evaluate the stability of the system using different frequency domain analysis tools • To design the compensator						

Course Outcomes	
CO1	Represent a system (in the form of transfer function) in MATLAB considering it's zeros, poles and gain.
CO2	Analyse the plots of time and frequency responses of SISO and MIMO systems.
CO3	Analyse the response of RLC circuit. Assess gain and phase margin to examine the effect of stability margins on closed loop response characteristics of a control system.
CO4	Frequency domain analysis for the given system

Exp. No.	Title of the Unit	Content of Experiment	Contact Hrs.	Mapped CO
1	Time domain analysis	Study of first order and second order system responses-measurement of system parameters in MATLAB	2	1
2	Stability Analysis	Check the stability of a system. Report whether the system is stable, unstable, or marginally stable.	2	3
3	Time domain analysis	Plotting unit step response of given transfer function and find peak overshoot, peak time.	2	2
4	State space	Finding state space representation of given closed loop system.	2	2
5	Stability Analysis	Plotting Bode plot of given transfer function and finding gain and phase margin.	2	4
6	Stability Analysis	Plotting Nyquist plot for given transfer function and to discuss closed loop stability, gain and phase margin	2	4
7	Stability Analysis	Plotting root locus of given transfer function and finding S, Wd, Wn at given root.	2	4
8	Stability Analysis	Plotting locus of given transfer function, locating closed loop poles for different value of k.	2	3

Reference Books:

M.Gopal, "Digital Control and State variable Methods", Tata Mc Graw Hill, 4th Edition, 2015

Ajit K.Madal, "Introduction to Control Engineering: Modelling, Analysis and Design" New Age International, 5th Edition, 2013.

K. Ogata, "Modern Control Engg.", PHI, 4th Edition, 2002.

S. K. Bhattacharya, "Control system Engg.", Pearson Education, 2nd Edition, 2008.

e-Learning Source:

https://nptel.ac.in/courses/108103007

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	2	3							2	2	2		3	3	3
CO2	3	3	3	2	3							2	2			3	3	3
CO3	3	1	1		3							2	2			3	3	1
CO4	3	3	2	3	3							2	2			3	3	1

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session:							
Course Code	**EE 336**	**Title of the Course**	**Industrial Automation Lab**	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	VI	**0**	**0**	**2**	**1**
Pre-Requisite		**Co-requisite**					
Course Objectives	• To provide the student with basic skills useful in identifying the concepts of automation using hydraulics, pneumatics, industrial sensors, PLC and distributed control strategies. • Student will be able to understand & develop the ladder program for DOL starter and its application as a timer. • Student will be able to understand the hardware & software used in PLC and Implementation of logic gates. • Student will be able to understand the Performance of Timers & Counters.						

Course Outcomes	
CO1	Student will be able to understand the hardware & software used in PLC and Implementation of logic gates.
CO2	Student will be able to understand & develop the ladder program for DOL starter and its application as a timer.
CO3	Student will be able to understand the hardware & software used in PLC and Implementation of logic gates.
CO4	Student will be able to understand the Performance of Timers & Counters.

Exp. No.	**Title of the Unit**	**Content of Experiment**	**Contact Hrs.**	**Mapped CO**
1	PlC Application	Study and use of Examine if closed (XIC) and Examine if open (XIO) bit instruction.	2	1
2	PlC Application	Study and Use of NOR Gate.	2	3
3	Latching	Study and use of Latch (L) and Unlatch (U) bit instruction.	2	2
4	Timer on and Timer Off	Study and use of ON Delay Timer (TON) and OFF Delay Timer (TOF) bit instruction.	2	2
5	Math instruction	Study and use of Compute Math (Addition) instruction.	2	3
6	Bit instruction	Study and use of Bit shift left (BSL) bit instruction.	2	4
7	Counter	Study and use of UP Counter (CTU) and of Down Counter (CTD) bit instruction.	2	4
	PlC Application	Study and use of Jump & Label Instruction.		1
8	Relay instruction	Study and use of MCR (Master Control Relay) instruction.	2	3

Reference Books:

Antony Espossito, “Fluid power with Applications ", Pearson, Sixth Edition., 2003

W. Bolton, “Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering” - PrenticeHall - 2013 – 5th Edition.

Singh, Shio Kumar. Industrial Instrumentation & Control, Tata McGraw-Hill Education, 2010.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	2	1	1	1	2							2	2	2		3	3	3
CO2	2	3	2	1	1	1						2	2			3	3	3
CO3	3	2	3	2	2	1	1					2	2			3	3	1
CO4	2	3	2	1	1	2						2	2			3	3	1

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session:							
Course Code	EE342	**Title of the Course**	**Soft Computing Lab**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	6th	**0**	**0**	**2**	**1**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To trace the historical developments of artificial intelligence leading to artificial neural networks (ANN). • Demonstrate an understanding of the fundamental properties of linear systems • Uses of transform analysis and convolution, to analyze and predict the behavior of linear time invariant systems • Understanding how to create fuzzy data sets; Understanding how fuzzy data sets can lead to better controller and control system. • To generate high-quality solutions to optimization and search problems by relying on biologically inspired operators such as mutation, crossover and selection.						

Course Outcomes	
CO1	To understand about artificial neuron and their architecture.
CO2	To understand the learning methods of artificial neurons and their memories.
CO3	To understand the difference between crisp sets and fuzzy sets.
CO4	To understand about fuzzy logics, mathematical tools.
CO5	To learn the optimization technique using genetic algorithm.

Unit No.	Title of the Unit	Content of Experiment	Contact Hrs.	Mapped CO
1		Realising Activation Function.	2	1
2		Realising XOR Function using McCulloch-Pitts Neuron.	2	1
3		Create a Perception Network (nntool).	2	2
4		To realize OR gate using nntool in MATLAB.	2	2
5		Develop a single input single output fuzzy logic controller using Fuzzy GUI in MATLAB.	2	3
6		Develop a double input single output fuzzy logic controller using Fuzzy GUI in MATLAB.	2	4
7		Develop a fuzzy logic cruise controller using Fuzzy GUI in MATLAB.	2	4
8		To minimize an objective function using the Genetic Algorithm.	2	5

Reference Books:

1. S. Rajashekharan & G.A. Vijay Lakshmi Pai , "Neural Network , Fuzzy logic and Genetic Algorithms: synthesis and applications", Prentice Hall India, 1st edition 2012.

2. Timonthy J.Ros " Fuzzy Logic with engineering applications" Will India, 2nd edition 2007.

3. S.N Sivanandam & S.N Deepa " Introduction to genetic algorithm" Springer 1st edition, 2008.

e-Learning Source:

NPTEL

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)															
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**3**	**2**	**2**		**1**			**1**	**1**		**1**	**1**	**1**	**1**	
CO2	**3**	**3**	**2**	**2**				**1**		**1**		**1**	**1**	**1**	**1**	
CO3	**3**	**3**	**2**	**2**		**1**			**1**	**1**		**1**	**1**	**1**	**1**	
CO4	**3**	**3**	**3**	**2**		**1**			**1**	**1**		**1**	**1**	**1**	**1**	
CO5	**3**	**3**	**2**	**2**		**1**		**1**		**1**		**1**	**1**	**1**	**1**	

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	**EE346**	**Title of the Course**	**Converter Lab**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**6th**	**0**	**0**	**2**	**1**
Pre-Requisite	**EE201**	**Co-requisite**	**NIL**				
Course Objectives	• Know about the the operation of single phase controlled converter using R and RL load. • Analyze single phase AC voltage control using TRIAC and the operation of a modified Mc-Murray Bedford full bridge inverter. • Know about the operation of inverters. • Analyze the operation of class D commutated technique and the operation of resistance triggering circuits of SCR. • Know about the operation of resistance capacitance triggering circuits of SCR and the operation of resistance, resistance capacitance and UJT triggering circuits of SCR.						

Course Outcomes	
CO1	Know about the the operation of single phase controlled converter using R and RL load.
CO2	Analyze single phase AC voltage control using TRIAC and the operation of a modified Mc-Murray Bedford full bridge inverter.
CO3	Know about the operation of inverters.
CO4	Analyze the operation of class D commutated technique and the operation of resistance triggering circuits of SCR.
CO5	Know about the operation of resistance capacitance triggering circuits of SCR and the operation of resistance, resistance capacitance and UJT triggering circuits of SCR.

Exp. No.	**Content of Experiment**	**Contact Hrs.**	**Mapped CO**
1	To study the operation of single phase half controlled converter using R and RL load and to observe the output waveforms.	2	1
2	To study the operation of single phase fully controlled converter using R and RL load and to observe the output waveforms.	2	1
3	To study the 1-phase AC voltage control using TRIAC.	2	2
4	To study the operation of a modified Mc-Murray Bedford full bridge inverter.	2	2
5	To study the operation of parallel inverter.	2	3
6	To study the operation of series inverter and to obtain variable AC from DC input.	2	3
7	To observe the operation of class D commutated technique.	2	4
8	To study the operation of resistance triggering circuits of SCR	2	4
9	To study the operation of resistance capacitance triggering circuits of SCR.	2	5
10	To study the operation of resistance, resistance capacitance and UJT triggering circuits of SCR	2	5

Reference Books:

1. Ned Mohan, Tore M, Undelnad, William P, Robbins (3rd Edition), "Power Electronics:Converters, Applications and Design," Wiley 2002.
2. L. Umanand, Power Electronics - Essentials and Applications; Wiley India Pvt. Ltd
3. P.C Sen.,' Modern Power Electronics ', Wheeler publishing Co, First Edition, New Delhi,1998.
4. M H Rashid, Power Electronics - Circuits, Devices and Applications; PHI, New Delhi.
5. Philip T Krein: Elements of Power Electronics; published by Oxford University Press

e-Learning Source:

PO-PSO	**Course Articulation Matrix: (Mapping of COs with POs and PSOs)**															
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	1	1	3	1	-	-	-	-	3	1	-	-	-
CO2	3	2	3	1	3	3	1	-	-	-	-	3	1	2	-	-
CO3	3	1	1	1	1	3	1	-	-	-	-	3	1	-	3	-
CO4	3	2	3	1	3	3	1	-	-	-	-	3	1	-	3	-
CO5	3	2	3	3	3	3	2	-	-	-	-	2	1	-	2	-

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2018-19							
Course Code	**EE401**	**Title of the Course**	**Power system Protection**	**L**	**T**	**P**	**C**
Year	**4th**	**Semester**	**7th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To learn the basics of relays. • To get the knowledge of relay application. • To gain the knowledge of protection of Transmission line. • To study the different types of circuit breaker. • To gain the knowledge of protection of Alternator.						

Course Outcomes	
CO1	Learn the basics of relays
CO2	Acquire knowledge of relay application
CO3	Acquire knowledge of protection of Transmission line
CO4	Knowledge the different types of circuit breaker
CO5	Gain the knowledge of protection of Alternator

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction to power system**	Introduction to protective system and its elements, Function of protective relaying, Protective zones, Primary and backup protection, Desirable qualities of protective relaying, Basic terminology. **Relays**: Electromagnetic, Attraction and induction type relays; Thermal relay; Gas actuated relay.	8	CO1
2	**Relay Applications and characteristics**	Amplitude and phase comparators, Over-current relays, Directional relays, Distance relays, Differential relays. **Static relays:** Comparison with electromagnetic relays, Classification and their description, Overcurrent relays, Directional relays, Distance relays, Differential relays	8	CO2
3	**Protection of Transmission line**	Time graded protection; Differential and distance protection of feeders; Choice between impedance, reactance and MHO relays; Elementary idea about carrier current protection of lines; Protection of bus; Auto reclosing, Pilot wire protection	8	CO3
4	**Breaking**	**Circuit Breaking:** Arc phenomenon, Properties of arc, Arc extinction theories, Recovery voltage and re-striking voltage, Current chopping, Resistance switching, Capacitance current interruption, Circuit breaker ratings. **Circuit breakers**: Need of circuit breakers; Types of circuit breakers; Operating modes; Principles of construction; Details of Air Blast, Bulk Oil, Minimum Oil, SF6, Vacuum Circuit Breakers, DC circuit breakers.	8	CO4
5	**Apparatus protection**	Types of faults on alternator, Stator and rotor protection, Negative sequence protection, Loss of excitation and overload protection, Types of faults on transformers, Percentage differential protection, Isolated neutral system, Grounded neutral system and selection of neutral grounding	8	CO5

Reference Books:

1. S. S. Rao, "Switchgear and Protection", Khanna Publishers, 13th Edition, 2008.
2. B. Ravindranath and M. Chander, "Power system Protection and Switchgear", Wiley Eastern Ltd., 5th Edison, 2015.
3. B. Ram and D. N. Vishwakarma, "Power System Protection and Switchgear", Tata McGraw Hill, 2nd Edition, 2011.
4. Y. G. Paithankar and S R Bhide, "Fundamentals of Power System Protection", Prentice Hall of India, 2004.
5. T.S.M. Rao, "Power System Protection: Static Relays with Microprocessor Applications", Tata McGraw Hill, 2nd edition, 1993.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3		1									1	2		2			
CO2	3	2		1									2	2	2			
CO3	3	2										1	2	2	2			
CO4	3	2		2								1	2	2	2			
CO5	3	1	2									1	2	2	2			

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2018-19							
Course Code	**EE403**	**Title of the Course**	**ELECTRIC DRIVES**	**L**	**T**	**P**	**C**
Year	**4th**	**Semester**	**7th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Describe the structure of Electric Drive systems and their role in various applications such as flexible production systems, energy conservation, renewable energy, transportation etc., making Electric Drives an enabling technology. • Analyze the operation of motor drives system to satisfy four-quadrant operation to meet mechanical load requirements. • Understand the basic principles of power electronics in drives using switch-mode converters and pulse width modulation to synthesize the voltages in dc and ac motor drives. • Describe the operation of induction machines in steady state that allows them to be controlled in induction-motor drives. Learn speed control of induction motor drives in an energy efficient manner using power electronics. • Learn the basic operation of stepper motors and switched-reluctance motor drives. • Realize an appreciation of power quality issues in powering electric drives.						

Course Outcomes	
CO1	**Conceptualize** fundamental elements of drive systems, **design** important elements of a drive system, **understand** the multi-quadrant operation and **analyze** it for different types of operation.
CO2	**Understand** and **evaluate** dynamics of motor-load combination, **Develop** the thermal model of a motor, **Analyze** steady state and transient state stability, **select** and **determine** the motor power rating for various duty cycles.
CO3	**Analyze** and **perform** the dynamics during starting and braking of DC and AC motor, **evaluate** energy loss and **implement** various methods to reduce it, **examine**, **develop** and **solve** various energy relations during starting and braking.
CO4	**Acquire** detailed knowledge of DC Shunt and Series motor operation using generalized machine theory, **Apply** the concepts of AC-DC and DC-DC Converters to evaluate and **enhance** the performance of steady and transient state operation, **Implement** speed control and current control loops of a DC Motor drive. **Understand** how DC Drives may pollute the power supply and **analyze** how to mitigate such pollution.
CO5	**Understand** the working of various phase controlled converters used in AC Drives**. Learn** the working principle and **design** details of frequency controlled converters used in induction motor drives. **Analyze** and **perform** the modeling and controlling CSI based drives.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Fundamentals of Electric Drives**	Electric drives and its parts, Advantages of electric drives, Classification of electric drives Speed torque conventions and multi-quadrant operations constant torque and constant power operation, Types of load torque: Components, Nature and Classification.	8	CO1
2	**Dynamics of Electric Drives**	Dynamics of motor-load combination; Steady state stability of Electric Drive; Transient stability of electric drive; Selection of motor power rating; Thermal model of motor for heating and cooling; Classes of motor duty; Determination of motor power rating for continuous duty, short time duty and intermittent duty; Load equalization.	8	CO2
3	**Electric Braking**	Purpose and types of electric braking; Braking of dc, three phase induction and synchronous motors; Dynamics during starting and braking of dc motors; Calculation of acceleration time and energy loss during starting of dc shunt and three phase induction motors; Methods of reducing energy loss during starting; Energy relations during braking, Dynamics during braking of ac motors.	8	CO3
4	**Power Electronic Control of DC Drives**	Single phase and three phase controlled converter fed separately excited dc motor drives (continuous conduction only); Dual converter fed separately excited dc motor drive; Rectifier control of dc series motor; Supply harmonics, power factor and ripples in motor current; Chopper control of separately excited dc motor and dc series motor.	8	CO4
5	**Power Electronic Control of AC Drives**	Three phase induction motor drive: Static voltage control scheme, Static frequency control scheme: VSI, CSI, and cyclo-converter based drives; Special drives: Switched reluctance motor, Brushless dc motor: Selection of motor for particular applications.	8	CO5

Reference Books:

1. G.K. Dubey, "Fundamentals of Electric Drives", Narosa publishing House, Reprint 2017.
2. S.K. Pillai, "A First Course on Electric Drives", Wiley Eastern Limited, 2nd Edition, 1989.
3. M. Chilkin, "Electric Drives", Mir Publishers, Moscow,1st Edition, 2002.
4. Mohammed A. El-Sharkawi, "Fundamentals of Electric Drives", Thomson Asia, Pvt. Ltd. Singapore, 1st Edition, 2000.
5. N.K. De and Prashant K. Sen, "Electric Drives", Prentice Hall of India Ltd., 1st Edition,2006.
6. V. Subrahmanyam

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3	1	1	2		1						2	2	1			
CO2	3	3	2	1	2							2	2	2	2			
CO3	3	3	2	2	2	2						1		2	2			
CO4	3	3	3	1	2	1		1			1		2		2			
CO5	3	3	3	2	2		1		1		1			1	2			

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2018-19							
Course Code	**EE421**	**Title of the Course**	**ELECTRICAL INSULATION IN POWER APPARATUS AND SYSTEM**	**L**	**T**	**P**	**C**
Year	**4th**	**Semester**	**7th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Knowledge and application of Theory of Break Down In Gaseous, Liquid and Solid dielectrics • Knowledge and application of Generation of High Voltage and Currents • Knowledge and application of Measurement of High Voltage and Currents • Knowledge and application of Over Voltage Phenomenon & Insulation Coordination • Knowledge and application of Non -Destructive Insulation Test Techniques						

Course Outcomes	
CO1	Understand and analyze the concept, design, technique, advancement and application of Break Down In Gases**,** electronegative gases, non-uniform field, vacuum, Liquid Dielectrics, pure liquid and commercial liquid, Solid Dielectric**,** solid dielectric in practice, composite dielectrics.
CO2	Understand and analyze the concept, design, technique, advancement and application of Generation of High direct Current Voltage, alternating voltages, impulse voltages, impulse currents and Tripping and control of impulse generators
CO3	Understand and analyze the concept, design, technique, advancement and application of Measurement of High direct Current Voltages; alternating & Impulse voltages, High direct, alternating & Impulse Currents and Cathode ray oscillographs for impulse voltage and current measurements
CO4	Understand and analyze the concept, design, technique, advancement and application of Lighting Phenomenon as natural cause for over voltage, Overvoltage due to switching surges and abnormal conditions and Principal of insulation coordination
CO5	Understand and analyze the concept, design, technique, advancement and application of Dynamic properties of dielectrics, Measurement of direct current resistivity, Measurement of dielectric constant and loss factor and Partial discharge measurements.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Break Down**	Break Down In Gases: Ionization processes, Townsend's criterion, Breakdown in electronegative gases, Time lags for breakdown, Streamer theory, Paschen's law, Breakdown in non- uniform field, Breakdown in vacuum. Break Down In Liquid Dielectrics: Classification of liquid dielectric, Characteristics of liquid dielectric, Breakdown in pure liquid and commercial liquid. Break Down In Solid Dielectric: Intrinsic breakdown, Electro-mechanical breakdown, Breakdown of solid dielectric in practice, Breakdown in composite dielectrics.	8	CO1
2	**Generation of High Voltage and Currents**	Generation of High direct Current Voltage, Generation of high alternating voltages, Generation of impulse voltages, Generation of impulse currents, Tripping and control of impulse generators	8	CO2
3	**Measurement of High Voltage and Currents**	Measurement of High direct Current Voltages; Measurement of High alternating & Impulse voltages; Measurement of High direct, alternating & Impulse Currents; Cathode ray oscillographs for impulse voltage and current measurements.	8	CO3
4	**Over Voltage Phenomenon & Insulation Coordination**	Lighting Phenomenon as natural cause for over voltage, Overvoltage due to switching surges and abnormal conditions, Principal of insulation coordination	8	CO4
5	**Non -Destructive Insulation Test Techniques**	Dynamic properties of dielectrics, Measurement of direct current resistively, Measurement of dielectric constant and loss factor, Partial discharge measurements.	8	CO5

Reference Books:

1. E. Kuffel, W.S. Zaengl and J. Kuffel, "High Voltage Engineering", CBS Publishers New Delhi, 2nd Edition, 2005.
2. M.S. Naidu & V. Kamaraju, "High Voltage Engineering", Tata McGraw Hill, 5th edition, 2013.
3. C.L. Wadhwa, "High Voltage Engineering", New Age Internationals (P) Limited, 3rd Edition, 2010.
4. M. Khalifa, "High Voltage Engineering: Theory and Practice", Marcel Dekker, 1st edition, 1990.
5. Subir Ray, "An Introduction to High Voltage Engineering", Prentice Hall of India, 2nd edition, 2013.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3	1	2	3							2	3	2	3			
CO2	3	3	1	2	3							2	3	2	3			
CO3	3	1	1	2	3							2	3	2	3			
CO4	3	1	1	2	3							2	3	2	3			
CO5	3	1	1	2	3							2	3	2	3			

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2018-19							
Course Code	**EE425**	**Title of the Course**	**EHVAC & EHVDC TRANSMISSION**	**L**	**T**	**P**	**C**
Year	**4th**	**Semester**	**7th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Knowledge of ENVAC and EHVDC Transmission • Design of EHV using software • Knowledge of control circuits used in power transmission network						

Course Outcomes	
CO1	Knowledge of EHVDC and EHVAC transmission and conductors used in transmission
CO2	Knowledge of switching and their effects on transmission circuits
CO3	Knowledge of single and three phase converters and design of EHV lines
CO4	Knowledge of different converters used in EHV DC transmission
CO5	Knowledge of protection circuits

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Introduction to**	Need of EHV transmission, Standard transmission voltage, Comparison of EHV ac & dc transmission systems and their applications & limitations, Surface voltage gradients in conductor,Distribution of voltage gradients on sub-conductors, Mechanical considerations of transmission lines, Modern trends in EHV AC and DC transmission	8	CO1
2	**EHV AC Transmission**	Corona loss formula, Corona current, Audible noise – generation and characteristics, Corona pulses their generation and properties, Radio interference (RI) effects, Over voltage due to switching, Ferro resonance, Reduction of switching surges on EHV system, Principle of half wave transmission.	8	CO2
3	**Consideration for Design of EHV Lines**	Design factors under steady state limits, EHV line insulation design based upon transient over voltages, Effects of pollution on performance of EHV lines. **Converter Circuits:** 1-phase and 3-phase converters (properties and configurations), Cascade of converters	8	CO3
4	**EHV DC Transmission–I**	Types of dc links, converter station, Choice of converter configuration and pulse number, Effect of source inductance on operation of converters, Principle of dc link control, Converter controls characteristics, Firing angle control, Current and excitation angle control, Power control, Starting and stopping of dc link	8	CO4
5	**EHV DC Transmission–II**	Converter faults; Protection against over currents and over voltages; Smoothing reactors; Generation of harmonics; AC and DC filters; Multi Terminal DC systems (MTDC): Types, Control,protection and applications.	8	CO5

Reference Books:

1. R. D. Begamudre, "Extra High Voltage AC Transmission Engineering", Wiley Eastern, 3rdedition, 2006.
2. K. R. Padiyar, "HVDC Power Transmission Systems: Technology and System Reactions",New Age International, 2nd edition, 1983.
3. M. S. Naidu & V. Kamaraju, "High Voltage Engineering", Tata McGraw Hill, 3rd edition,2004.
4. M. H. Rashid, "Power Electronics: Circuits, Devices and Applications", Prentice Hall ofIndia, 4th edition, 2014.
5. S. Rao, "EHV AC and HVDC Transmission Engineering and Practice", Khanna Publisher,4th edition, 2011.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	2										2	3					
CO2	3	2										2	3	2	2			
CO3	2	3	2									2	2	3	2			
CO4	3	2	3									2	2	2				
CO5	3	2										2	3					

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2018-19							
Course Code	**EE427**	**Title of the Course**	**POWER SYSTEM DYNAMICS**	**L**	**T**	**P**	**C**
Year	**4th**	**Semester**	**7th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To understand the students about dynamics of Power systems. To develop ability for analysis of system stability and obtain the solution of transient problems. • To analyze the modeling of synchronous machine by applying fundamental law's. • To realize and examine the excitation systems and response the behavior of prime mover controllers in different system. • To recognize the concepts of dynamics of synchronous generator Connected to Infinite Bus by investigation in real time domain. • To execute the analysis of transient and voltage stability by various parameters and comparison with angle stability						

Course Outcomes	
CO1	Given a Power System Dynamics Problems, students shall be able to represent this in various conventional models, identify type of system, apply vector algebra, and formulate the expression in different System Model and solve using mathematical terms.
CO2	Given a Modeling of Synchronous Machine with sources, student shall be able to analyze System Simulation and evaluate the Steady State Performance using Equivalent Circuit of Synchronous Machine.
CO3	For a Excitation systems & Prime Mover Controllers, student shall be able to generate its analytical response by Standard Block Diagram and examine, analyze and evaluate the characteristics by State Equations and Load Modeling.
CO4	For a given System Model, students shall be able to identify its characteristics and for Stator Equation, select suitable design of application of Network Equation, develop various combination for System Simulation Small Signal Analysis with Block Diagram Representation for Single Machine System.
CO5	Given a Modeling and Analysis of Transient and Voltage Stability, student shall be able to define its Stability Evaluation, solve/ analyze, and modify energy functions for direct stability Evaluation.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Power System Dynamics Problems**	Introduction, General basic concept of Power System Stability, States of operation & System Security, System Dynamics Problems, Review of Classical Model, System Model, Analysis of Steady State Stability & Transient Stability	8	CO1
2	**Modelling of Synchronous Machine**	Introduction, System Simulation, Park's Transformation, Analysis of Steady State Performance, P.U. Quantities and Equivalent Circuit of Synchronous Machine.	8	CO2
3	**Excitation systems & Prime Mover Controllers**	Simplified Representation of Excitation Control, Excitation systems, Modelling, Standard Block Diagram, State Equations, Prime Mover Control System, Transmission Line & Load Modelling	8	CO3
4	**Dynamics of Synchronous Generator Connected to Infinite Bus**	System Model, Stator Equation, Rotor equations, Application of Model 1.1, Network Equation, Calculation of Initial Conditions, System Simulation Small Signal Analysis with Block Diagram Representation for Single Machine System, Synchronizing & Damping Torque Analysis, State Equation.	8	CO4
5	**Modelling and Analysis of Transient and Voltage Stability**	Simulation for Transient Stability Evaluation; Application of energy functions for direct stability evaluation; Voltage Stability: Introduction, Factors affecting voltage collapse, Analysis and comparison with angle stability.	8	CO5

Reference Books:

1. K. R. Padiyar, "Power System Dynamics: Stability & Control", BS Publications, 2nd edition, 2002
2. I. J. Nagrath and M. Gopal, **"**Control system engineering**",** Wiley Eastern Ltd, 3rd edition, 2000.
3. Benjamin C. Kuo, **"**Automatic Control system**",** Prentice Hall of India Pvt. Ltd, 8th edition, 2003.
4. Prabha Kundur, **"**Power System Stability and Control**"**, Tata McGraw Hill, 5th edition, 2014

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2										2	3	1			
CO2	3	3	2	2	2								2	3	1			
CO3	3	3	1									2	2	3	1			
CO4	3	2	3	2	3					2	2		2	3				
CO5	3	3	3			2	1						2	3	1			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2018-19							
Course Code	**EE431**	**Title of the Course**	**UTILIZATION OF ELECTRICAL ENERGY AND TRACTION**	**L**	**T**	**P**	**C**
Year	**4th**	**Semester**	**7th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To impart the detail knowledge of different types of Electrical Heating • To understand about Electrical Welding, Refrigeration and Air conditioning. • To study different definitions of Illuminations and its Laws • To understand types of Electric Traction, system of track electrification, Tractive effort. • Study of salient features of traction Drives. To impart knowledge of Diesel Electric Traction						

Course Outcomes	
CO1	**Conceptualize** fundamental elements of electrical heating, **designing** of different elements used in electrical heating, **understand** working and application of different type of furnaces.
CO2	**Understand** different types and working of electrical welding, **understand** different instrument used for electrical welding. **Acquire** detailed knowledge electro-deposition, laws of electrolysis and its application in different field.
CO3	**Acquire** knowledge of different Laws of Illuminations, **Develop** the designing skill for indoor and outdoor lighting system. **Understand** construction and operation of Refrigeration and air conditioner system, **Analyze** the electric circuit and **Learn** the maintenance of domestic refrigerator.
CO4	**Understand** operation, mechanism and types of track electrification used of a traction system. **Acquire** detailed knowledge of different terminology used in electric traction.
CO5	**Acquire** knowledge of different motor drives operation, **Analyze** starting, braking and of different type of motor drives used for traction **Apply** the concepts of AC-DC and DC-DC Converters for traction drives, **Implementation** of bridge transition speed control of a DC traction drive. **Understand** the concept of diesel electric traction.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Electric Heating**	Advantages and methods of electric heating, Resistance heating, Electric arc heating, Induction heating, Dielectric heating.	8	CO1
2	**Electric Welding**	Electric Arc Welding, Electric Resistance welding, Electronic welding control Electrolyte Process: Principles of electro-deposition, Laws of electrolysis, Applications of electrolysis	8	CO2
3	**Illumination**	Various definitions, Laws of illumination, Requirements of good lighting, Design of indoor lighting and outdoor lighting systems. Refrigeration and Air Conditioning: Refrigeration systems, Domestic refrigerator, Water cooler,Types of air conditioning, Window air conditioner	8	CO3
4	**Electric Traction I**	Types of electric traction; Systems of track electrification; Traction mechanics - Types of services, Speed time curve and its simplification, Average and schedule speeds; Tractive effort; Specific energy consumption; Mechanics of train movement; Coefficient of adhesion and its influence.	8	CO4
5	**Electric Traction II**	Salient features of traction drives, Series – parallel control of dc traction drives (Bridge transition) and energy saving Power Electronic control of dc and ac traction drives, Diesel electric traction	8	CO5

Reference Books:

1. H. Partab, “Art and Science of Electrical Energy”, Dhanpat Rai & Sons, 2014
2. G.K. Dubey, “Fundamentals of Electric Drives”, Narosa Publishing House, 2nd edition,2015.
3. H. Partab, “Modern Electric Traction”, Dhanpat Rai & Sons, 2013
4. C.L. Wadhwa, “ Generation, Distribution and Utilization of Electrical Energy”, New Age International Publications, 3rd edition, 2010
5. E. Open Shaw Taylor, “Utilization of Electric Energy”, Orient Longman, Reprint 2011.

e-Learning Source:

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	1	2	2	2			2		1	2	2	3			
CO2	3	3	2	1	2	2	2			2		1	2	1	3			
CO3	3	3	3	3	3	3	3	2	3	3	1	2	2		2			
CO4	3	3	3	1	1	3		1		1		2	2	1	2			
CO5	3	3	2	2	1	2	1	1	1	2		3	2					

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2018-19							
Course Code	**EE435**	**Title of the Course**	**HIGH VOLTAGE DC TRANSMISSION**	**L**	**T**	**P**	**C**
Year	**4th**	**Semester**	**7th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To introduce students with the concept of HVDC Transmission system. • To familiarize the students with the HVDC converters and their control system. • To expose the students to the harmonics and faults occur in the system and their prevention. • To Develop the knowledge of HVDC transmission and HVDC converters and the applicability and advantage of HVDC transmission over conventional AC transmission. • To Formulate and solve mathematical problems related to rectifier and inverter control methods and learn about different control schemes as well as starting and stopping of DC links • To Analyze the different harmonics generated by the converters and their variation with the change in firing angles. • To Develop harmonic models and use the knowledge of circuit theory to develop filters and assess the requirement and type of protection for the filters. • To Study and understand the nature of faults happening on both the AC and DC sides of the converters and formulate protection schemes for the same. • To Review the existing HVDC systems along with MTDC systems and their controls • To Recognize the need to follow the advancements in both the existing systems and HVDC systems and determine the most economic coexistence of both.						

Course Outcomes	
CO1	Choose intelligently AC and DC transmission systems for the dedicated application(s).
CO2	Identify the suitable two-level/multilevel configuration for high power converters.
CO3	Select the suitable protection method for various converter faults.
CO4	Decide the configuration for harmonic mitigation on both AC and DC sides.
CO5	Identify suitable reactive power compensation method and basics of MTDC system.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**General Aspects of HVDC Transmission**	Introduction to HVDC Transmission, Comparison of HVAC and HVDC systems (Economics of power transmission, Technical Performance and Reliability), Type of HVDC Transmission systems, Description of HVDC transmission system (Types of DC Links and Converter), Planning for HVDC transmission, Modern trends in HVDC technology	8	CO1
2	**Converters**	Simple rectifier circuits, Rectification circuits for HVDC transmission, HVDC converters (Line commutated and Voltage Source converters), Analysis of Graetz Bridge with and without overlap, Pulse number, 12 pulse firing schemes	8	CO2
3	**HVDC System Control**	HVDC system control (Principles of DC link control, Firing Angle Current and extinction angle control), Converter mal-operations, Commutation failure, Converter control characteristics, Power Control, Starting and stopping of converter bridge, Converter protection, DC Breakers.	8	CO3
4	**Reactive Power And Harmonics Control**	Reactive power requirements, Sources of Reactive Power, Smoothing reactor and DC Lines, Generation of Harmonics, Characteristic and Non-characteristic Harmonics, Troubles due to Harmonics, Harmonics Filters (AC Filters and DC Filters), Active Filters and Passive Filters	8	CO4
5	**Power Flow Analysis**	Interaction between AC and DC system, Power Flow in AC/DC Systems, DC system model, Basics of Multi-terminal DC (MTDC) system, Types of Multi-terminal DC (MTDC) system, Multi-In feed DC System	8	CO5

Reference Books:

1. Padiyar K.R., "HVDC transmission system", Wiley Eastern Ltd., New Delhi, Second Edition, 2015.
2. Arrilaga J., "High voltage direct current transmission", Peter Pereginver Ltd. London, U.K., 1998.
3. Kim Bark E.W., "Direct current transmission – Vol.1", Wiley Inter Science, New York, 1971.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2								2	2	1		1			
CO2	3	3	2	2	2							2	2	2				
CO3	3	3	1									1	2	2				
CO4	3	2	3	2	3					2	2	3	1	2	1			
CO5	3	3	3			2	1				2	3	1					

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2018-19							
Course Code	**EE437**	**Title of the Course**	**ELECTRICAL DISTRIBUTION SYSTEM & AUTOMATION**	**L**	**T**	**P**	**C**
Year	**4th**	**Semester**	**7th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives							

Course Outcomes	
CO1	Knowledge of energy losses, OHTL and UG lines
CO2	Analyze and modelling of distribution system
CO3	Design of distribution system
CO4	Protection analysis of distribution system
CO5	Knowledge of automation systems and sensors

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Industrial and commercial distribution system**	Energy Loss in distribution system, System ground for safety and- protection, Comparison of overhead lines and underground cable system	8	CO1
2	**Network model**	Power flow, short circuit and calculations, Distribution system reliability analysis, Reliability concepts, Markov model, Distribution network reliability, Reliability performance	8	CO2
3	**Distribution system expansion planning**	Load characteristics, Load forecasting, Design concepts, Optimal location of sub-station, Design of radial lines, Solution technique	8	CO3
4	**System protection**	Requirement; Fuses and section analyzers; Over current, under voltage and under frequency protection; Co-ordination of protective device	8	CO4
5	**Industrial Automation and Control**	Introduction to Industrial Automation and Control Architecture of Industrial Automation Systems, Introduction to sensors and measurement systems, Temperature measurement, Pressure and Force measurements, Displacement and speed measurement, Flow measurement techniques, Measurement of level.	8	CO5

Reference Books:

1. Pabla. A.S., “Electrical Power Distribution, System”, Tata McGraw Hill, 1981.
2. Tuvar Goner, "Electrical Power Distribution System”, McGraw Hill, 1986.
3. Johnson C.D., "Process control instrumentation technology", Prentice-Hall, New Delhi,2006
4. Kalsi H.S., “Electronic Instrumentation”, McGraw Hill, 3rd edition, New Delhi, 2010

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	2	2									2	3		2			
CO2	2	3	3										2	3				
CO3	3	2	3									3	3	3	3			
CO4	3	2	2									3	3					
CO5	3											3	3					

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2018-19							
Course Code	**EE439**	**Title of the Course**	**HIGH POWER SEMICONDUCTOR DEVICES**	**L**	**T**	**P**	**C**
Year	**4th**	**Semester**	**7th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Knowledge of latest semiconductor switches • Apply knowledge of thyristors in hardware based models						

Course Outcomes	
CO1	To understand the construction and working of power switches like diode, transistor, IGBT and their practical applications in industries.
CO2	Analysis of different types thyristors their practical implementation. To understand the different methods to turn it on and their blocking characteristics.
CO3	To understand the structure and operation of MOSFET, Silicon IGBT, Silicon carbide IGBT and its practical application in electrical devices for industries.
CO4	To understand the operation and structure of VMOS and DMOS and its practical application in electrical devices for industries.
CO5	To understand the operation and structure of silicon MCT, BRT, EST, Gallium Nitride devices and its practical application in electrical devices for industries.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Introduction**	Power Switching Waveforms, High Voltage Power Device Structures, Breakdown Model for Silicon, High Voltage Applications	8	CO1
2	**SCR**	Operation & structure of Silicon Thyristors, Silicon Carbide Thyristors & Silicon GTO, Blocking characteristics	8	CO2
3	**Power Bipolar Transistors**	Operation and structure of Silicon IGBT, SiC Planar MOSFET Structures and Silicon Carbide IGBT	8	CO3
4	**Power MOS Devices**	Operation and structure of V MOS and DMOS, Heat Transfer in Power MOS devices, Device packaging	8	CO4
5	**High Voltage Devices**	Operation and structure of silicon MCT,silicon BRT,silicon EST,Gallium nitride devices	8	CO5

Reference Books:

1. B. Jayant Baliga, "Fundamentals of Power Semiconductor Devices", 3rd edition, Springer, 2008
2. B. Jayant Baliga, "Advanced High Voltage Power Device Concepts", 1st edition, Springer, 2011
3. Robert Perret, "Power Electronics Semiconductor Devices", 1st edition, Wiley, 2009
4. Tadahiro Ohmi, Andre A. Jaecklin, "Power Semiconductor Devices & Circuits", 1st edition,Springer, 1992
5. Josef Lutz, Heinrich Schlangenotto, Uwe Scheuermann, Rik De Doncker, "SemiconductorPower Devices", Springer, 1st edition, 2011

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	1	1	1	1	2	2	1					3	2	1			
CO2	3	2	3	2	2	3	1	1	1				3	1	2			
CO3	3	2	3	2	2	2	2	1	1		1	2	3	2	2			
CO4	3	2	3	2	3	2	2	1	1		3	2	3	2	2			
CO5	3	2	3	2	3	2	2		1		3	2	3	2	2			

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2018-19							
Course Code	**EE441**	**Title of the Course**	**FLEXIBLE AC TRANSMISSION SYSTEMS**	**L**	**T**	**P**	**C**
Year	**4th**	**Semester**	**7th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To familiarize power engineers about the Flexible AC Transmission devices and their applications in power systems with respect to active/reactive power control.						

Course Outcomes	
CO1	Understand the importance of controllable parameters and benefits of FACTS controllers.
CO2	Know the significance of shunt, series compensation and role of FACTS devices on system control.
CO3	Analyze the functional operation and control of GCSC, TSSC and TCSC.
CO4	Describe the principles, operation and control of UPFC and IPFC.
CO5	Knowledge of UPFC and IPFC

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Introduction to FACTS**	Challenges and needs, Power Flow in AC transmission line, Power flow control, Description and definition of Flexible AC Transmission Systems (FACTS) controllers, Static power converter structures.	8	CO1
2	**Power Semiconductor devices**	Types of power semiconductor devices, Voltage-sourced and Current-sourced converters, Converter output and harmonic control, Power converter control issues, Reactive power compensation.	8	CO2
3	**Shunt Compensation**	Static VAR compensator (SVC), Static Synchronous Compensator (STATCOM), Thyristor controlled Reactor (TCR) and Thyristor switched Reactor (TSR) Operation and control, Configurations and applications	8	CO3
4	**Series Compensation:**	Thyristor Controlled Series Capacitor (TCSC), Static Synchronous Series Compensator (SSSC), Operation and control, Configurations and applications. Voltage and Phase angle regulators: Thyristor controlled voltage regulators (TCVRs) and Thyristor controlled phase angle regulators (TCPARs) operation and control.	8	CO4
5	**Shunt-Series compensation**	Unified power flow controller (UPFC), Power flow studies with FACTS controllers, Operational constraints, Interline Power flow Controller (IPFC), Operation and control.	8	CO5

Reference Books:

1. Narain G. Hingorani, " Understanding FACTS", Wiley IEEE PRESS, Reprint 2015.
2. K.R. Padiyar, "FACTS Controllers in Transmission & Distribution", 3rd edition 2017.
3. V. K. Sood, "HVDC and FACTS Controllers: Applications of Static Converters in Power Systems", 2004.
4. Enrique Acha, C.R. Feurte, Esquivel, "Modelling and Simulation in Power Networks", Wiley-India edition, 2004.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3		1				2	1			2	2	2			
CO2	3	3	3	1			3		3	1	3		2	2	2			
CO3	3	3	3	1					3	1	3	1	2	2	2			
CO4	3	3	3	1					3	1		1	2	2	2			
CO5													2	2	2			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2018-19							
Course Code	**EE443**	**Title of the Course**	**SPECIAL ELECTRICAL MACHINES**	**L**	**T**	**P**	**C**
Year	**4th**	**Semester**	**7th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Knowledge of slip power recovery scheme • To get knowledge of constructional features of special machines such as single-phase synchronous motor and ac servomotor. • To attain knowledge of working of stepper motor and switched reluctance motor and their drive circuits • To study about different types of magnets and their application in different machines • To have the knowledge of working and application of linear induction motor and universal motor.						

Course Outcomes	
CO1	Evaluate the performance special induction motors and slip power recovery schemes
CO2	Analyze the performance of single-phase synchronous motor and ac servomotor
CO3	Evaluate the performance of drive circuit of stepper motors
CO4	Knowledge of permanent magnet machines
CO5	Knowledge of linear induction motor and universal motor used for special applications

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Poly-phase AC Machines**	Construction and performance of double cage and deep bar three phase induction motors, E.m.f. injection in rotor circuit of slip ring induction motor, Concept of constant torque and constant power controls, Static slip power recovery control schemes (constant torque and constant power).	8	CO1
2	**Single phase synchronous motor**:	Construction, Operating principle and characteristics of reluctance and hysteresis motors. Two Phase AC Servomotors: Construction, Torque-speed characteristics, Performance and applications.	8	CO2
3	**Stepper Motors:**	Principle of operation; Variable reluctance, Permanent magnet and Hybrid stepper motors; Characteristics, drive circuits and applications. Switched Reluctance Motors: Construction, Principle of operation, Torque production, Modes of operation, Drive circuits.	8	CO3
4	**Permanent Magnet Machines**	Types of permanent magnets and their magnetization characteristics, Demagnetizing effect, Permanent magnet dc motors, Sinusoidal PM ac motors, Brushless dc motors and their important features and applications, PCB motors, Introduction to permanent magnet generators.	8	CO4
5	**Single Phase Commutator Motors**:	Construction, Principle of operation; Characteristics of universal and repulsion motors; Linear Induction Motors: Construction, Principle of operation, Linear force and applications.	8	CO5

Reference Books:

1. P.S. Bimbhra "Generalized Theory of Electrical Machines", Khanna Publishers Limited, 5th Edition, 4th Reprint, New Delhi, 2000
2. P.C. Sen, "Principles of Electrical Machines and Power Electronics", John Wiley & Sons, 2nd edition, 2001.
3. G.K. Dubey, "Fundamentals of Electric Drives", Narosa Publishing House, 2nd edition, reprint 2017.
4. Cyril G. Veinott, "Fractional and Sub-fractional horse power electric motors", McGraw Hill International, 1986
5. M.G. Say, " Alternating current Machines", Pitman & Sons, 4th edition, 1976

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	2	2	1								1	2	2	2			
CO2	3	2										1	3	2	2			
CO3	3	3	2	2								1	3	2	1			
CO4	3	2										1	2	1	2			
CO5	3	1										1	3	1	1			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2018-19							
Course Code	**EE445**	**Title of the Course**	**ELECTRICAL SYSTEM & SUBSTATION DESIGN**	**L**	**T**	**P**	**C**
Year	**4th**	**Semester**	**7th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To develop knowledge of general aspects of electrical system design • Having Knowledge of Medium and HV installations • Having knowledge of installation of transformers, Switchgears and protective devices • To get knowledge of Design of illumination systems • To get the knowledge of different types of substation, Substation equipment and its function.						

Course Outcomes	
CO1	Understands the general aspects of electrical system design
CO2	Selection of main distribution board; Sub distribution board; MCCB, ELCB, MCB and cables for sub circuits
CO3	Understand installation of transformers, Switchgears and protective devices
CO4	Knowledge of Design of illumination systems
CO5	Knowledge of types of substation, substation equipment and its function.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**General Aspects**	National Electric Code (NEC) - scope and safety aspects applicable to low and medium (domestic)voltage installations, Electric services in buildings, Classification of voltages, Standards and specifications, IE Rules, IS Codes, General aspects of the design of electrical installations for domestic buildings – connected load calculation.	8	CO1
2	**Distribution board**	Selection of main distribution board; Sub distribution board; MCCB, ELCB, MCB and cables forsub circuits; Pre-commissioning tests of domestic installations; Medium and HV installations –Selection of cables, Guidelines for cable installation & installation of induction motors.	8	CO2
3	**Transformers**	Selection and installation of transformers, Switchgears and protective devices; Design of indoor and outdoor 11 KV substation up to 630 KVA: Design of Earthing system - Pipe, plate and mat earthing; Lightning arresters; Metering and protection; HT and LT breaker control panels; Selection of standby generator, installation and its protection.	8	CO3
4	**Illumination systems**	Design of illumination systems – Yard lighting, Street lighting and Flood lighting; Design and layout of installation for recreational or assembly buildings and high rise building; Design of Electrical system related to fire fighting, lifts and escalators.	8	CO4
5	**Substation**	Types of Substation, Substation equipment and its function, Bus bar arrangement, Single busbar systems and duplicate bus-bar systems, Capacitor bank, Earthing practices, Substation automation.	8	CO5

Reference Books:

1. M.K.Giridharan, “Electrical System Design”. I.K. International Pvt. Ltd., 2011.
2. Raina & Bhattacharya, “Electrical Design Estimating and Costing”. New Age International,1st Edition, 1991.
3. Bureau of Indian Standards publications, “National Electric Code”, 1986.
4. S.N. Singh, “Electric Power Generation, Transmission & Distribution”, PHI, 2015

1. M.K.Giridharan, “Electrical System Design”. I.K. International Pvt. Ltd., 2011.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	2		1								1	3		2			
CO2	3	2					1					1		2				
CO3	3	1										2		3				
CO4	3	2										1		3				
CO5	3	2					1					1	2					

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2018-19							
Course Code	**EE447**	**Title of the Course**	**ELECTRIC VEHICLES**	**L**	**T**	**P**	**C**
Year	**4th**	**Semester**	**7th**	**3**	**1**	**0**	**4**
Pre-Requisite	1. Basic Electrical Engg. 2.Electromechanical Energy Conversion I and II 3.Power Electronics	**Co-requisite**	None				
Course Objectives	• Knowledge of different types of electric vehicles • Knowledge of different types of converters used in electric vehicles • Knowledge of current sensors and speed sensors used in electric vehicles • Knowledge of charge controllers and batteries used in electric vehicles • To identify different types of electric vehicles on the basis of performance						

Course Outcomes	
CO1	Knowledge of different electric vehicles and their environmental impact
CO2	Knowledge of different types of converters used in electric vehicles
CO3	Knowledge of current sensors and speed sensors used in electric vehicles
CO4	Knowledge of charge controllers and batteries used in electric vehicles
CO5	Identify different types of electric vehicles

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Introduction of Electric Vehicles**	Introduction, Types of electric vehicles, History of Electrical Vehicles (EV), Configurations of Electric Vehicles, Relative merits and their limitations, Applications, Environmental impact.	8	CO1
2	**Converters**	Introduction and working of semiconductor power diode, Thyristors and MOSFET. Power electronic converters: DC-DC and DC-AC converters for electric and hybrid vehicles.	8	CO2
3	**Motors & Sensors: EV motors**	PMDC, Series motors, Induction Motors, Switched reluctance motor. Sensors: Hall Effect sensors, optical encoders, current and speed sensing, closed loop speed control of vehicle.	8	CO3
4	**Battery and Charge Controllers: Battery**	Basic, Type, Parameters, Capacity, Discharge Rate, State of Charge, Depth of Discharge, Characteristics, Properties of Batteries. Charge Controllers: Purpose, Working and Limitations.	8	CO4
5	**Electric Vehicles: Hybrid Electric Vehicles**	Types, Performance Parameters, Advantages and Disadvantages, Limitations. Electric Cars: Emerging Trend, Hybrid Cars, Acceleration and Speed Characteristics, Fuel Cell Vehicles: Fundamentals, Advance Hybrid Electric Vehicles	8	CO5

Reference Books:

1. James Larminie, "Electric Vehicle Technology Explained", John Wiley & Sons, 2003.

2.Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles Fundamentals", CRC Press, 2010.

3.Sandeep Dharmeja, " Electric Vehicle Battery System", Newnes, 2011

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	2						3					1	2	2	2			
CO2	3					2						1	3	3	2			
CO3		3	2									1	3	2	2			
CO4	3	1										2	2	3	2			
CO5					1		3					2	2	3	2			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	**EE449**	**Title of the Course**	**ENERGY CONSERVATION AND ENERGY AUDIT**	**L**	**T**	**P**	**C**
Year	**4th**	**Semester**	**7th**	3	1	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To Give the basic knowledge of the energy management. • To make aware the students about Lighting System. • To provide the knowledge of decentralized energy supply to agriculture, industry, commercial and household sector. • Assessment of transmission and distribution efficiency, Energy conservation in buildings.						

Course Outcomes	
CO1	Student understands the basic concept of energy, limitations faced in the energy conservation, and classification & importance of energy auditing.
CO2	Ability to understand the concepts of energy audit and produce the knowledge of energy conservation in boiler and steam based systems.
CO3	After completion of the subject, the understanding of the factors affecting the energy conservation and design consideration would be clear.
CO4	For a given refrigeration and air conditioning system, students shall be able to identify its characteristics. Select suitable design of application with various combination for System.
CO5	For a given Energy management system, student shall be able to define its process, different types of control strategies, and compensators.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Introduction**	Energy Scenario, Role of Energy Managers in Industries, Energy monitoring, Auditing & targeting, Economics of various Energy Conservation schemes, Total Energy Systems	8	CO1
2	**Energy Audit**	Energy Audit, Types of energy audit, Identification of energy conservation opportunities, Various Energy Conservation Measures in Steam Losses in Boiler, Energy Conservation in Steam Systems –Case studies.	8	CO2
3	**Energy conservation**	Classification of energy conservation measures, Energy conservation in Centrifugal pumps, Fans & Blowers, Air compressor energy consumption & energy saving potentials, Design consideration.	8	CO3
4	**Refrigeration & Air conditioning**	Heat load estimation, Components of Heating ventilation and air conditioning (HVAC) system, Energy conservation opportunities in HVAC system-Case studies, Energy Efficiency in Lighting-Case studies.	8	CO4
5	**Energy management & process**	Organizational background desired for energy management motivation; Detailed process of M&T; Thermostats; Boiler controls- proportional, differential and integral control; Optimizers; Compensators.	8	CO5

Reference Books:

1. Eastop T.D. & Croft D.R., "Energy Efficiency for Engineers and Technologists", Logman Scientific & Technical, ISBN-0-582-03184, 1990.
2. Reay D.A., "Industrial Energy Conservation", Pergamon Press, 1st edition,1977.
3. Kothari D. P., Nagrath I. J., "Power System Engineering", Tata McGraw-Hill Co., 2nd Ed., 2008.
4. Singh S., Rathore U., "Energy Management", S. K. Kataria & sons, 2nd edition, 2017.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	1	2	3	1					1			1	2	1	2			
CO2	1	3	3	1		1	2	1		1		1	3	1	3			
CO3	1	3	2	2		1	2	1		1		1	2	1	2			
CO4	1	3	2	3		1	2	1		1		1	2	3	2			
CO5	1	2	3	2		1	2	1		1		1	2	1	2			

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2018-19							
Course Code	**EE 402**	**Title of the Course**	**Power system protection lab**	**L**	**T**	**P**	**C**
Year	**4th**	**Semester**	7th	**0**	**0**	**2**	**1**
Pre-Requisite		**Co-requisite**					
Course Objectives	• To understand and experiment with operation of relays. • To understand and experiment with operational characteristics of relays. • To understand and experiment with impedance calculation of transformer. • To understand and experiment with voltage ratio test of Transformer.						

Course Outcomes	
CO1	Adopt, perform, analyze and implement the operational characteristic of under and over voltage relays.
CO2	Adopt, perform, analyze and implement the operational characteristic of IDMT and earth fault relays.
CO3	Adopt, perform, analyze and implement the operational characteristic of differential and thermal relays.
CO4	Adopt, perform, analyze and implement the to study and calculate impedance and transformation ratio of the given transformer.

Exp. No.	**Content of Experiment**	**Contact Hrs.**	**Mapped CO**
1	Operational characteristic of under voltage relay.	2	1
2	Operational characteristics of over voltage relay.	2	1
3	Operational characteristic of IDMT relay.	2	2
4	Operational characteristic of earth fault relay.	2	2
5	Operational characteristic of differential relay.	2	3
6	Operational characteristic of thermal relay.	2	3
7	To study and calculate impedance of the given transformer.	2	4
8	To study and calculate voltage ratio test of the given transformer.	2	4

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)															
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	2	3							2	2	2		3
CO2	3	3	1	2	3							2	2			3
CO3	3	1	1		3							2	2			3
CO4	3	1	1		3							2	2			3

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2018-19							
Course Code	**EE404**	**Title of the Course**	**Electric Drive Lab**	**L**	**T**	**P**	**C**
Year	**IV**	**Semester**	VII	**0**	**0**	**2**	**1**
Pre-Requisite		**Co-requisite**	EE403				
Course Objectives	• To impart knowledge on Performance of the fundamental control practices associated with AC and DC machines (starting, reversing, braking, plugging, etc.) using power electronics. • To evaluate the use of microcontroller-based analysis tools to review the major classes of machines and their physical basis for operation.						

Course Outcomes	
CO1	Identify relevant information to supplement to the Electric Drives (EE403) course.
CO2	Set up control strategies to synthesize the voltages in dc and ac motor drives.
CO3	Develop testing and experimental procedures applying basic knowledge in electrical circuit analysis, electrical machines, power electronics, and microprocessors.
CO4	Combine the use of microcontroller-based tools relevant to electrical Drives with practical laboratory experimentation.

Exp. No.	**Content of Experiment**	**Contact Hrs.**	**Mapped CO**
1	To study the single phase half controlled bridge convertor.	2	1,3
2	To study the single phase fully controlled bridge convertor.	2	1,3
3	To study control of 3-phase induction motor using v/f control.	2	1,2
4	To study the dc motor speed controller.	2	1,2
5	To study MOSFET based chopper motor controller.	2	1,4
6	To study micro controller based speed control of 1-phase induction motor by voltage control.	2	1,2,4
7	To study the micro controller based single phase dual converter.	2	1,3,4
8	To study the micro controller based 3-phase fully controlled bridge converter.	2	1,3,4

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)															
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	2				1				2	3	2		
CO2	1	3		2	3								3		2	
CO3	2	1	3	2			2		2	1		2		2	1	
CO4	1			1		2					2	2	2		1	

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	**EE-513**	**Title of the Course**	**Advance Power Electronics**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	**1st**	4	0	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Knowledge and concept of voltage source inverter. • Use of switching techniques/schemes and current source inverters. • Knowledge and concept of multilevel inverters, its applications and control • Identify and apply concept of resonant converters. • Knowledge of synchronous rectifiers and matrix converters.						

Course Outcomes	
CO1	Know about the concepts of voltage source inverter
CO2	Identify and apply switching techniques/schemes and current source inverters
CO3	Know about concept of multilevel inverters, its applications and control.
CO4	Identify and apply concept of resonant converters
CO5	Know about synchronous rectifiers and matrix converters.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Switch-Mode Inverters**	Basic concepts of voltage source inverter (VSI), current source inverters (CSI), single phase half bridge, full bridge and three phase bridge inverters.	8	CO1
2	**Switching Strategies**	PWM switching strategies, Selective Harmonic Elimination method, other inverter switching schemes, Modulation index, Modulation frequency and its effect on switching	8	CO2
3	**Multi-Level Inverters**	Need for multilevel inverters, Types, three level, five level inverter operation and analysis. Applications of multilevel inverters and control.	8	CO3
4	**Resonant Converters**	Basic resonant circuit concepts, Load resonant converters, series and parallel, resonant switch converters – Zero voltage switching (ZVS), Zero current switching (ZCS), comparison of resonant converters.	8	CO4
5	**Miscellaneous Converters**	Multilevel converters topologies: Cascaded, NPC, Flying Capacitor MLI, Synchronous rectifiers, matrix converters,	8	CO5

Reference Books:

1. Ned Mohan, “Power Electronics Converters, Applications, and Design” John Wiley (SEA), 3rd Ed 2014.
2. M. H. Rashid “Power Electronics” PHI Learning
3. G. K. Dubey, “Power Semi-Conductor Controllers”, Wiley Eastern, 2nd Edition, 2012.
4. R W Erickson and D Maksimovic “Fundamental of Power Electronics” Springer, 2ndEdition.
5. M.H. Rashid, “Hand book of Power Electronics”, 4th Edition,2013.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	2	1	1	3	3	1					1	2	2			
CO2	3	2	2	2	3	3	3						1	2	2			
CO3	3	2	2	1	1	3	3	1					1	2	1			
CO4	3	2	2	2	3	3	3						3	2	1			
CO5	3	3	3	3	3	3	2						2	3	1			

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	**EE-514**	**Title of the Course**	**Power Apparatus & System Modelling**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	**1st**	4	0	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	To understand the fundamental concepts of application of Parks transformation To develop knowledge on principles of modelling of synchronous generators To evaluate the performance of different excitation systems To analyze governors for thermal and hydro power plant To provide advanced knowledge and understanding about the models of transmission line, transformer and load						

Course Outcomes	
CO1	Apply Parks transformation technique
CO2	Understands the basic concept of modelling of synchronous generators
CO3	Evaluate the performance of AC and DC excitation system
CO4	Analyze governors for thermal and hydro power plant
CO5	Understand different models of transmission line, transformer and load

UnitNo.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Synchronous Generator Modeling**	Schematic diagram, equivalent circuit, Starting method, balanced operation, Park's transformation (dqo transformation)	8	CO1
2	**Dynamic Modeling of Synchronous Generator**	Modeling of synchronous generator with damper windings; Synchronous Machine Parameters: operational and standard, Effect of Saturation on Synchronous Machine Modelling.	8	CO2
3	**Modelling of Excitation systems**	Excitation system requirements, Types of Excitation system, Control and protective function of Excitation system, Modelling of various Excitation system, IEEE type various DC, AC and Static models.	8	CO3
4	**Prime Movers Modelling**	Steam turbine and Governing system: Various configurations of Steam turbine of fossil- fueled and nuclear units, Modelling of Steam turbine and its governing systems. Hydraulic turbine and Governing system : Hydraulic turbine transfer function, linear and Non-linear turbine model, Modelling of Governors for Hydraulic turbine	8	CO4
5	**Modelling of Other Power System Components**	Induction Motor, Synchronous Motor, Transformers, transmission lines, Static and Dynamic loads, Selected FACTS Controllers (SVC and TCSC).	8	CO5

Reference Books:

1. A.A. Foud & P.M. Anderson, "Power System Stability and Control", Galgotia Press, New Delhi, 2014
2. L.P. Singh, "P.S. Analysis and Dynamics", Wiley Eastern, Delhi, 2014
3. P. Kundur, "Power System Stability and Control", Mc-Graw Hill, 2010
4. K. R. Padiyar, "Power System Dynamics: Stability and Control", B.S. Publication, 2008

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2		1								3	3	2	3			
CO2	3	2						1				3	3	2	2			
CO3	3	1									2	3	3	2	3			
CO4	3	2									1	3	3	2	2			
CO5	3	2						1				3	3	2	3			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	**EE-515**	**Title of the Course**	**Advance Power System Analysis**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	**1st**	4	0	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Knowledge of graph theory, bus admittance and impedance matrices • Knowledge of algorithm of bus impedance matrix and short circuit studies using three-phase Impedance Z_{BUS} • Knowledge of power flow solutions • Knowledge of Contingency and security studies • Knowledge of Modern energy control Techniques						

Course Outcomes	
CO1	Solve the problem of graph theory, bus admittance and impedance matrices
CO2	Able to attain the knowledge of algorithm of bus impedance matrix and short circuit studies using three-phase Impedance Z_{BUS}
CO3	Able to solve the problems of power flow solutions
CO4	Having knowledge of Contingency and security studies
CO5	Having knowledge of Modern energy control Techniques

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Introduction**	System graph, loop, cut-set and incidence matrices; Algorithms for the formation of bus admittance and impedance matrices, Three-phase Admittance YBUS and Impedance ZBUS matrices;Optimal load flow	8	CO1
2	**Power flow solutions**	Gauss-Seidel, Newton-Raphson, Approximation to Newton-Raphson Method, Line flow equations and Decoupled and Fast decoupled techniques.	8	CO2
3	**Fault Analysis**	Symmetrical faults, Fault calculations using ZBUS, Unsymmetrical faults-Problems on various types of faults.	8	CO3
4	**Contingency and security studies**	Factors affecting security, State transition diagram, Contingency analysis using network sensitivity method and AC power flow method.	8	CO4
5	**Modern energy control Techniques**	Modern energy control centres, Introduction to Supervisory Control and Data Acquisition in power systems(SCADA), benefit of SCADA, Remote terminal and connection, Human machine interface	8	CO5

Reference Books:

1. G.W. Stagg & A.H. Al-Abiad, “Computer Methods in Power Systems”, Mc-Graw Hill, 1998.
2. Haadi Sadat, “Power System Analysis”, Tata McGraw Hill, 2002
3. M.A. Pai, “Computer Techniques in Power System Analysis”, Tata McGraw Hill, 2014
4. D. P. Kothari and I. J. Nagrath, “Modern Power System Analysis”, Tata McGraw Hill, 2014

e-Learning Source:

Course Articulation Matrix: (Mapping of COs with POs and PSOs)																		
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	3	3	3		2							2	2	2			
CO2	2	3	3	3		2							2	3	2			
CO3	1	3	3	3		2							2	2	2			
CO4	1	2	3	3		2							1	2	3			
CO5	2	3	3	3		2							1	3	3			

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE-517**	**Title of the Course**	**POWER SYSTEM DYNAMICS & CONTROL**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	**1st**	4	0	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To understand the students about dynamics of Power systems. To develop ability for analysis of system stability and obtain the solution of transient problems. • To analyze the modeling of synchronous machine by applying fundamental law's. • To realize and examine the excitation systems and response the behavior of prime mover controllers in different system. • To recognize the concepts of dynamics of synchronous generator Connected to Infinite Bus by investigation in real time domain. • To execute the analysis of transient and voltage stability by various parameters and comparison with angle stability.						

Course Outcomes	
CO1	Given a Power System Dynamics Problems, students shall be able to represent this in various conventional models, identify type of system, apply vector algebra, and formulate the expression in different System Model and solve using mathematical terms.
CO2	Given a Modeling of Synchronous Machine with sources, student shall be able to analyze System Simulation and evaluate the Steady State Performance using Equivalent Circuit of Synchronous Machine
CO3	For a Excitation systems & Prime Mover Controllers, student shall be able to generate its analytical response by Standard Block Diagram and examine, analyze and evaluate the characteristics by State Equations and Load Modeling.
CO4	For Stator Equation, select suitable design of application of Network Equation, develop various combination for System Simulation Small Signal and large signal analysis with Block Diagram Representation for Single Machine System,
CO5	Given a Modeling and Analysis of Transient and Voltage Stability, student shall be able to define its Stability Evaluation, solve/ analyze, and modify energy functions for direct stability evaluation;

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Analysis of Dynamical Systems**	Concept of Equilibrium, Small and Large Disturbance Stability, Single Machine Infinite Bus System, Modal Analysis of Linear Systems, Analysis using Numerical Integration Techniques, Issues in Modelling: Slow and Fast Transients, Stiff Systems.	8	CO1
2	**Modelling of a Synchronous Machine**	Physical Characteristics, Rotor Position Dependent model, D-Q Transformation, Model with Standard Parameters, Steady State Analysis of Synchronous Machine, and Synchronous Machine Connected to Infinite Bus.	8	CO2
3	**Modelling of Excitation and Prime Mover Systems**	Physical Characteristics and Models, Control system components, Excitation System Controllers, Prime Mover Control Systems.	8	CO3
4	**Modelling of Transmission Lines and Loads**	Transmission Line Physical Characteristics, Transmission Line Modelling, Load Models - induction machine model, Other Subsystems - HVDC, protection systems.	8	CO4
5	**Stability Issues in Interconnected Power Systems**	Single Machine Infinite Bus System, Multi-machine Systems, Stability of Relative Motion. Frequency Stability: Centre of Inertia Motion, Single Machine Load Bus System: Voltage Stability, Torsional Oscillations, Real-Time Simulators.	8	CO5

Reference Books:

1. K.R.Padiyar, Power System Dynamics, Stability & Control, 2nd Edition, B.S. Publications, Hyderabad, 2002.
2. P.Kundur, Power System Stability and Control, McGraw Hill Inc, New York, 1995.
3. P.Sauer & M.A.Pai, Power System Dynamics & Stability, Prentice Hall, 1997.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	2										3		1			
CO2	3	3	2	2	2								3		3			
CO3	3	3	1											3	2			
CO4	3	2	3	2	3					2	2		2		1			
CO5	3	3	3			2	1							3	2			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE-518**	**Title of the Course**	**Computer Aided Power System Analysis**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	**2nd**	4	0	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Determination of network sensitivity, • Analyze load flow using iterative methods • Fault analysis estimation						

Course Outcomes	
CO1	Analysis of power system network in term of matrices
CO2	Load flow analysis using iterative methods
CO3	Analysis of fault under balance and unbalanced condition
CO4	Estimation of the state of the power system using statistical tools
CO5	Analysis of load frequency control for single area and multi area system

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Introduction**	Solution of Linear Systems and Contingency Analysis, Matrix representation of power systems, Triangularization, Gaussian elimination, LU and LDU factorization LDLT decomposition for sparse Matrices, Optimal ordering, Overview of Security Analysis, Linear Sensitivity Factors, Contingency Selection, Calculation of Network Sensitivity Factors.	8	CO1
2	**Load Flow**	Load Flow Analysis Newton–Raphson iteration, Power system applications: Power flow, Formulation of Bus admittance matrix, regulating transformers, Gauss-Seidel, Newton-Raphson and Fast Decoupled methods of power flow, Treatment of voltage-controlled buses, Accelerating factors, DC load flow.	8	CO2
3	**Power flow solutions**	Short Circuit Studies, System Representation, Algorithm for formation of bus impedance matrix, Balanced fault, Sequence impedances of power system components, Unbalanced fault Analysis.	8	CO3
4	**Power System State Estimation**	Power System State Estimation, Power system state estimator, Method of Least Squares, Statistics, Errors and Estimates, Test for bad data, Network Topology Processing.	8	CO4
5	**Modern control Techniques**	Unit Commitment and Load Frequency Control, Constraints in UC, Solution Methods of UC, Automatic Load Frequency Control of Single Area System and Multi Area System, Steady State Instabilities.	8	CO5

Reference Books:

1. Hadi Saadat, “Power System Analysis”, Tata Mc Graw Hill, 2003.

2. A. J. Wood and B.F.Wollenberg, “Power Generation Operation and Control”, John Wiley & Sons, ICN., 2nd Edition.

3. A. K.Mahalanabis, “Computer Aided Power system analysis and control”, Tata McGraw Hill 1991 4. John J. Grainger, William D. Stevenson, JR. “Power System Analysis”, McGraw Hill, 1994.

5. Elgerd olleI, “Electric Energy Sytems Theory- An Introduction”, Tata Mc Graw Hill, 2ed. 1995.

6. I. J. Nagrath & D.P. Kothari, “Modern Power System Analysis”, Tata McGraw Hill,1989

7.Wadhwa C L, “Electrical Power Systems”, New Age Publication, 3ed., 2002

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	1	2	3										2	3	1			
CO2		3	2										2	3	2			
CO3	2	3	2										3	2	2			
CO4	2	3	2										3	2	3			
CO5	2	2	2										2	2	2			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE-519**	**Title of the Course**	**ADVANCE RELAYING AND PROTECTION**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	**2nd**	4	0	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Apply the knowledge of relays in power system protection						

Course Outcomes	
CO1	To learn the basics of relays
CO2	Knowledge of relay applications
CO3	Knowledge of protection of generator, motors and transformers
CO4	Study of different types of system grounding, faults and protection
CO5	Knowledge of digital relays

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Protective Relaying**	Relay terminology, Definitions, Classification, electromechanical, static and digital-numerical relays. Design-factors affecting performance of a protection scheme; faults-types and evaluation, Instrument transformers for protection.	8	CO1
2	**Relay Schematics and Analysis**	Over Current Relay- Instantaneous/Inverse Time –IDMT Characteristics; Directional Relays; Differential Relays- Restraining Characteristics; Distance Relays: Types- Characteristics.	8	CO2
3	**Protection of Power System Equipments**	Generator, Transformer, Transmission Systems, Busbars, Motors; Pilotwire and Carrier Current Schemes.	8	CO3
4	**System Grounding**	Ground faults and protection; Load shedding and frequency relaying; Out of step relaying; Re-closing and synchronizing.	8	CO4
5	**Basic Elements Of Digital Protection**	Digital signal processing, Digital filtering in protection relay, Digital Data transmission, Numeric relay hardware, relay algorithm, distance relays, direction comparison relays, differential relays, software considerations, numeric relay testing.	8	CO5

Reference Books:

1. A T John and A K Salman-Digital protection for power systems-IEEE power series-15, Peter Peregrines Ltd, UK,1997
2. C.R. Mason, The art and science of protective relaying, John Wiley &sons, 2002
3. Donald Reimert, Protective relaying for power generation systems, Taylor & Francis-CRC press 2006
4. Gerhard Ziegler-Numerical distance protection, Siemens, 2nd ed, 2006
5. A.R.Warrington, Protective Relays, Vol .1&2, Chapman and Hall, 1973
6. T S.Madhav Rao, Power system protection static relays with microprocessor applications, Tata McGraw Hill, 1994
7. Helmut Ungrad , Wilibald Winkler, Andrzej Wiszniewski, Protection techniques in electrical energy systems, Marce Dekker, Inc. 1995
8. Badri Ram , D.N. Vishwakarma, Power system protection and switch gear, Tata McGraw Hill, 2001.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3			1									1	2	1			
CO2	3	2		1									2	1	1			
CO3	3	1			1								1	2	2			
CO4	3	1		2									2	1	3			
CO5	3	1	2		1								3	1	1			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	EE 520	**Title of the Course**	**POWER GENERATION OPERATION AND CONTROL**	1	0	4	**C**
Year	**1st**	**Semester**	2nd	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	**1. Acquaint electric power engineering students with power generation systems, their operation in an economic mode, and their control.** **2. Introduce students to the important "terminal" characteristics for thermal and hydroelectric power generation systems.** **3. Introduce mathematical optimization methods and apply them to practical operating problems.** **4. Introduce methods for solving complicated problems involving both economic analysis and network analysis and illustrate these techniques with relatively simple problems.**						

Course Outcomes	
CO1	Understand the Characteristics of power generation units
CO2	Develop the knowledge of Transmission lines
CO3	Analyze the unit commitment techniques
CO4	Analyze the performance of scheduling energy
CO5	Understand the application of Gradient and Newton method

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction	Characteristics of power generation units(thermal, nuclear, hydro, pumped hydro), variation in thermal unit characteristics with multiple valves, Economic dispatch with and without line losses, lambda iteration method, gradient method, Newton's method, base point and participation factors.	8	CO1
2	Transmission losses	Co-ordination equations, incremental losses, penalty factors, B matrix loss formula (without derivation), methods of calculating penalty factors.	8	CO2
3	Unit commitment	Constraints in unit commitment, priority list method, Dynamic programming method and Lagrange relaxation methods. Generation with limited energy supply: take or pay fuel supply contract, composite generation production cost function, gradient search techniques.	8	CO3
4	Hydrothermal Coordination	Scheduling energy, short term hydrothermal scheduling, lambda-gamma iteration method, gradient method, cascaded hydro plants, pumped storage hydro scheduling.	8	CO4
5	Optimal power flow formulation	Gradient and Newton method, linear programming methods. Automatic voltage regulator, load frequency control, single area system, multi-area system, tie line control.	8	CO5

Reference Books:

1. Allen. J. Wood and Bruce F. Wallenberg, "Power Generation Operation and Control', John Wiley & Sons, Inc., 3rd Edition 2011.

2. Olle.I.Elgerd, "Electric Energy Systems theory – An introduction", Tata McGraw Hill Education Pvt. Ltd., New Delhi, 34th reprint, 2010

3. Abhijit Chakrabarti, Sunita Halder, "Power System Analysis Operation and Control", PHI learning Pvt. Ltd., New Delhi, Third Edition, 2010.

4. N.V.Ramana, "Power System Operation and Control," Pearson, 2011.

e-Learning Source:

NPTEL

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2	1	1							3	3	2	1	3		
CO2	3	3	3	2	1	1						2	3	2	2	2		
CO3	3	2		1	2	2	3					3	2	2	1	3		
CO4	3	2	2	2	3	3						2		3	1	2		
CO5	3	1	1	1	1	2	1					2	3	1	2	2		

2- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE-521**	**Title of the Course**	**High Voltage Testing Techniques**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	**2nd**	4	0	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Knowledge of different types of HV testing methods used in testing electrical equipment's						

Course Outcomes	
CO1	Determination of switching surges using impulse testing on generators
CO2	Determination of voltage time characteristics for different specimens
CO3	Determination of voltage time characteristics for insulators, bushings etc.
CO4	Analyze the results of impulse and p.f. tests on dielectrics
CO5	Analyze the transformers, capacitors and cables with different types of HV tests

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Generation of High Voltages and Currents**	Need and importance of impulse testing. Study of impulse voltage and current generators -- Generators for Lightning and Switching Impulse Voltages, Chopped Impulse Voltages, Steep-Front Impulse Voltages, Exponential Impulse Currents, Rectangular Impulse Currents. .	8	CO1
2	**Volt-time characteristics I**	Method of wave shaping and oscillographic measurement; Volt-time characteristics of rod-rod, sphere-sphere, rod-plane gaps.	8	CO2
3	**Volt-time characteristics II**	Volt-time characteristics of insulators, bushings, gaps of positive and negative polarity, horn gap, rod gap, lightning arresters – expulsion type, valve type.	8	CO3
4	**Testing Techniques I**	Current testing of lightning arresters – Long duration impulse current test, Operating Duty Cycle Test; Testing of dielectrics – Power frequency tests, Impulse tests; Applications of insulating materials.	8	CO4
5	**Testing Techniques II**	Testing of transformers – Induced over voltage test, Partial discharge test, Impulse test; Testing of Capacitors; Testing of Cables - Dielectric Power Factor Test, High Voltage Tests, Partial discharge measurement.	8	CO5

Reference Books:

1. M.S. Naidu & V. Kamaraju, "High Voltage Engineering", McGraw-Hill, 2014
2. C.L. Wadhwa, "High Voltage Engineering", New Age International Publishers, 2014
3. Subir Ray, "An Introduction to High Voltage Engineering", Prentice Hall of India, 2004.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	2	3										1	2	1			
CO2	2	3	2										1	1	1			
CO3	3	2	2										1	1	1			
CO4	2	2	3										1	1	1			
CO5	3	2	3										1	1	1			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE-522**	**Title of the Course**	**Power System Stability**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	**2nd**	4	0	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Knowledge of different types of HV testing methods used in testing electrical equipment's						

Course Outcomes	
CO1	Knowledge of different types of power system stability
CO2	To get knowledge of energy function
CO3	To attain knowledge of modelling of machines
CO4	To study about power system stabilizer
CO5	To have the knowledge of voltage stability

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Power System Stability**	States of operation, Basic concepts of angular and voltage stability. Angular stability: Analysis of single machine and multi-machine systems for transient stability.	8	CO1
2	**Energy function**	Digital simulation and energy function methods. Energy function analysis of single machine system. Small signal stability (dynamic stability)	8	CO2
3	**Modeling of machines**	Modeling for single machine and multi-machine systems, Synchronizing and damping torque analysis, Eigen value and time domain analysis.	8	CO3
4	**Power System Stabilizer (PSS)**	Mitigation using power system stabilizer and FACTS controllers. Basic concepts in applying PSS, Control Signals, Structure and tuning of PSS Introduction to sub synchronous resonance.	8	CO4
5	**Voltage stability**	Power-Voltage (P-V) and Reactive Power-Voltage (Q-V) curves, static analysis, sensitivity and continuation method. Dynamic analysis.	8	CO5

Reference Books:

1. P. Kundur Power System Stability and Control, Mc - Graw Hill .

2. K. R. Padiyar Power System Dynamics, Stability & Control, Interline Publishers, Bangalore

3. P. Saur and M. A. Pai Power System Dynamics & Stability, Prentice Hall

4. G.W. Stagg & A.H. Al Abiad Computer Methods in Power System, Mc - Graw Hill

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	1	1	1	1	1	1				3			2	2			
CO2	3	3	3	2	2	1					3		1	2				
CO3	3	2	2	2	2	1					3		2	3				
CO4	3	1	1	1	1	1	1				3			2	3			
CO5	3	1	1	1	1	1	1				3			2				

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE-523**	**Title of the Course**	**Advance Electric Drives**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	**2nd**	4	0	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Knowledge of AC and DC drives • Evaluate performance of drives • Modelling of drives using software						

Course Outcomes	
CO1	Analyze the motoring and braking operation in drives
CO2	Control the motors using different methods
CO3	Mathematical modelling of different drives topologies
CO4	Analyze the drives under unbalanced condition
CO5	Analyze different types of SM drives

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**DC Motor Drive**	Characteristics of different dc motors: their speed control and braking operations: Converter fed dc motor drives: Analysis for motoring and braking operations. Dynamic modelling of dc motor drives; Closed-loop control; Dual converter fed dc motor drives.	8	CO1
2	**Induction Motor Drive I**	Equivalent circuit; Performance & Characteristics under motoring and braking operations. Speed control methods and their analysis: voltage control, V/f control, static-rotor resistance control	8	CO2
3	**Induction Motor Drive II**	Field Oriented Control of IM: configurations, mathematical modelling. VSI- and CSI- based schemes, Slip-power recovery schemes: static Scherbius and Kramer drives, Doubly-fed IM drive.	8	CO3
4	**Synchronous Motor Drives I**	Equivalent circuit, motoring and braking operations, Operations with non-sinusoidal power supplies; Speed control	8	CO4
5	**Synchronous motor drives II**	Load Commuted Inverter (LCI) fed synchronous motor drives, Switched and Synchronous reluctance motor drives	8	CO5

Reference Books:

1. "Power Electronics and Motor Drives – Advances and Trends" IEEE Press, 2006 by B.K. Bose.
2. "Power S.C.drives" Prentice-Hall 1989 by G.K. Dubey.
3. "Electric Motor Drives", , Modeling, Analysis and Control", Prentice Hall of India, 2002 by R. Krishnan
4. "High Power Converters and AC Drives"IEEE Press, A John Wiley and Sons, Inc., 2006 by Bin Wu.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3										1	3	2			
CO2	3	2	2										1	2	3			
CO3	3	3	2										2	3	3			
CO4	2	2	2												2			
CO5	2	2	3										2					

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	**EE-611**	**Title of the Course**	**FACTS DEVICES & HVDC TRANSMISSION**	**L**	**T**	**P**	**C**
Year	**2nd**	**Semester**	**3rd**	4	0	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To understand the use of different power electronic devices in HVDC Transmission. • To impart knowledge of different Voltage Source Converters used in HVDC Transmission • To impart knowledge of different Self and Line Commutated Current Sourced Converters used in HVDC Transmission. • To understand working and characteristics of different FACTS devices used in HVDC Transmission. • To understand working and characteristics and comparison of Combined Compensators used in HVDC Transmission. To understand working of Interline power flow controller.						

Course Outcomes	
CO1	Understand the different type power electronic devices and their characteristics, used for FACTS controller, Recognized different issues in ac power transmission, .Implement of different FACTS controller for power flow control
CO2	Impart knowledge of working, control function and behavior under different loading condition of various type of Voltage Source Converters used in power Transmission,
CO3	Developed complete understanding of different type of Self and Line Commutated Current Sourced Converters used power flow control, Analyze between VSC & CSI
CO4	Explain basic objectives of using series and shunt compensator, Understand working, characteristics and control of different FACTS devices used in power transmission.
CO5	Understand working, characteristics and comparison of Combined Compensators used for power flow control, Explain the working and control of Interline power flow controller

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**FACTS concepts and General system considerations**	Introduction to power semiconductor devices: Diode, GTO, MOSFET, IGBT, MOS Controlled Thyristor; Transmission interconnection; Power flow in ac system; Power flow and dynamic stability considerations; Basic of FACTS controllers: Shunt, Series, Combined and other controllers; FACTS technology; HVDC or FACTS.	8	CO1
2	**Voltage Source Converters**	Basic concepts, Single phase full wave bridge converter operation, Three phase full wave bridge converter, Sequence of valve conduction process in each phase leg, Transformer connections for 12 pulse operation, Three level voltage sourced converter, PWM converter	8	CO2
3	**Self and Line Commutated Current Sourced Converters**	Basic concepts, Three phase full wave diode rectifier, Thyristor based converter, Rectifier and inverter operation valve voltage and commutation failure, Current sourced versus voltage sourced converters	8	CO3
4	**FACTS Devices**	Introduction, Objectives of shunt compensation, Methods of controllable VAR Generation, Static VAR Compensators, SVC and STATCOM, Static series compensators, TSSC, TCSC and SSC	8	CO4
5	**Combined Compensators**	Introduction, Unified power flow controller (UPFC), Conventional power control capabilities, Real and reactive power flow control, Comparison of UPFC to series compensators, Control structure, Dynamic performance, Interline power flow controller basic operating principles, Control structure, Application considerations.	8	CO5

Reference Books:

1.N.G. Hingorani and L. Ayugyi, "Understanding FACTS concepts and Technology of Flexible AC Transmission system", Standard Publication, New Delhi, 2001

2.K.R. Padiar, "HVDC power transmission", New Age International, 1990

3.J. Arrillaga, "High voltage direct current Transmission", IET digital library, 2nd Edition, 1998

4.E.W. Kimbark, "Direct Current transmission", Wiley-Blackwell, 1st Edition, 1971.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	2	1	2	1	2	2	1	1		2	2	1			
CO2	3	3	2	2	2	1	1	2	3	1	1		2	3				
CO3	3	3	1	1	2		1	2	2	1			2	2				
CO4	3	3	2	2	2			2	3	1			2	2	3			
CO5	3	3	2	2	2			2	2	1	1		2	3	2			

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	EE 612	**Title of the Course**	**POWER SYSTEM OPTIMIZATION**	1	0	4	**C**
Year	**2nd**	**Semester**	3rd	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	**1. Acquaint electric power engineering students with knowledge of optimization techniques** **2. Introduce students to the important Quadratic programming.** **3. Introduce Linear programming** **4. Introduce methods for Application of population based optimization techniques in power systems**						

Course Outcomes	
CO1	Understand the optimization techniques fundamentals
CO2	Develop quadratic programming
CO3	Analyze the performance linear programming problem
CO4	Analyze the performance of optimization algorithm
CO5	Understand the application of population based optimization techniques in power systems

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Fundamentals of optimization techniques	Fundamentals of optimization techniques: Definition, Classification of optimization problems, Unconstrained and Constrained optimization, Optimality conditions, Classical Optimization techniques (Lamda Iteration method, Linear programming, Quadratic programming). Lamda iteration method: Brief introduction to Lamda iteration method, Formulation of the Lagrange function, Lamda iteration method to solve optimal dispatch problem.	8	CO1
2	Quadratic programming	Introduction to quadratic programming, Working principle, Sequential programming, Linear constrained optimization problem, Karush-Kuhn-Tucker conditions and its application to solve various problems, Interior point method, Lagrangian duality.	8	CO2
3	Linear programming	Examples of linear programming problem, The Simplex Method I, Fundamental theorem of linear programming, Weak and strong duality theorems, Integer programming, Network flow, Development of a linear programming model from problem description.	8	CO3
4	Particle Swarm Optimization	Fundamental principle; Velocity Updating; Advanced operators; Parameter selection; Hybrid approaches (Hybrid of GA and PSO, Hybrid of EP and PSO) - Binary, Discrete and combinatorial	8	CO4
5	Application of population based optimization techniques in power systems	Algorithms and flow chart of various optimization techniques for solving economic load dispatch and hydro-thermal scheduling problem.	8	CO5

Reference Books:

1. S. S. Rao, "Engineering Optimization", New Age International (P) Ltd, 3rd Edition, 2013.

2. S.N.Sivanandam & S.N. Deepa, "Principle of soft computing", 2nd Edition, 2011.

3. Jizhong Zhu, "Optimization on Power system Operation", Wiley-IEEE Press, 2nd Edition, 2015

4. K.P. Chong, Stanislaw H. Zak, "An Introduction to Optimization", Wiley online library, 3rd Edition, 2011.

e-Learning Source:

NPTEL

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2	1	1	3						3	3	2	1	3		
CO2	3	3	3	2	1	1						2	3	2	2	2		
CO3	3	2	1	1	2	2	3					3	2	2	1	3		
CO4	3	2	2	2	3	3						2	3	3	1	2		
CO5	3	1	1	1	1	2	1					2	3	1	2	2		

2- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2023-24							
Course Code	**EE-616**	**Title of the Course**	**SCADA SYSTEMS AND APPLICATIONS**	**L**	**T**	**P**	**C**
Year	**2nd**	**Semester**	**3rd**	3	0	0	3
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To apply knowledge gained about PLCs and SCADA systems to real-life industrial applications. • Investigate various industrial communication technologies.Learn and apply the SCADA Applications in various real life applications.						

Course Outcomes	
CO1	Understand the fundamentals of SCADA systems and its various functions.
CO2	Acquire knowledge regarding SCADA System Components and Programmable Logic Controller (PLC).Learn and discover how to set up industrial data communications networks
CO3	Increase knowledge of the key industrial communication protocols.Understand the different industrial communicationsnetworks used.And make aware of Security system in Communication.
CO4	Make aware students in the field of application.They become familiar to the SCADA system working, maintenance and desiredsecurity modes.

UnitNo.	**Title of the Unit**	**Content of Unit**	**ContactHrs.**	**MappedCO**
1	Introduction	Data acquisition system, Evaluation of SCADA (Supervisory Control and Data Acquisition system), Objectives, Benefits, Functions, Monitoring & Control usingSCADA.	8	CO1
2	SCADA system components	Communication Interface, Remote terminal unit, Intelligent electronic devices, Master station, HMI (Human machine interface system),PLC(Programmable LogicControllers),Sensors.	8	CO2
3	SCADA Communication	General Overview of SCADA Communications, Communications Network Options,Communication Security , Protocols in SCADA Communication, IEC 60870- 5, T101,DNP3 Protocol, Profibus, RP-570, Conitel, Modbus RTU, WebAccess HMI& SCADA features, Typical System Configurations(point to point, point to multipoint), Modes of Communication (Polled System,Interrupt system)	8	CO3
4	SCADA Applications	Automation of Electrical Distribution system, Substation control,Feeder control, EndUser load control automation by SCADA,Advantages of implementing SCADA system for electrical Distribution, Water Pumping Station,Oil & Gas Industry,WaterRecycling Plant Monitoring and Control.	8	CO4

Reference Books:

1. Stuart A. Boyer, "SCADA-Supervisory Control and Data Acquisition", Instrument Society of America Publications, USA, 4th edition,2009.

2. Gordon Clarke, Deon Reynders, "Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Newnes Publications, Oxford, UK, 2004.

3. William T. Shaw, "Cyber security for SCADA systems", Penn Well Books, 2006.

4. David Bailey, Edwin Wright, "Practical SCADA for industry", Newnes, 2003.

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	2	1	2	1	2	2	1	1		2	2	1			
CO2	3	3	2	2	2	1	1	2	3	1	1		2	3				
CO3	3	3	1	1	2		1	2	2	1			2	2				
CO4	3	3	2	2	2			2	3	1			2	2	3			

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE-621**	**Title of the Course**	**SOFT COMPUTING IN SOLAR PV AND WIND ENERGY CONVERSION SYSTEMS**	**L**	**T**	**P**	**C**
Year	**2nd**	**Semester**	**3rd**	4	0	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Knowledge and concept of electricity generation through Solar PV system. • Use of soft computing techniques in electricity generation through Solar PV system. • Knowledge and concept of electricity generation through Wind energy conversion system. • Use of soft computing techniques in electricity generation through Wind energy. • Designing of hybrid power generation systems using soft computing						

Course Outcomes	
CO1	Know about the concept of electricity generation through Solar PV system.
CO2	Identify and apply soft computing techniques in electricity generation through Solar PV system
CO3	Know about concept of electricity generation through Wind energy conversion system.
CO4	Identify and apply soft computing techniques in electricity generation through Wind energy
CO5	Design hybrid power generation systems using soft computing.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Solar PV Energy Conversion Systems**	Solar PV Energy Conversion Systems Basics of Solar PV; PV Module Performance Measurements; Balance of System and Applicable Standards; Types of PV Systems: Grid-Connected Solar PV System, Stand-Alone Solar PV System, PV-Hybrid Systems, Stand-Alone Hybrid AC Solar Power System with Generator and Battery Backup; Charge Controller; Batteries in PV Systems; Maximum Power Point Tracking Techniques.	8	CO1
2	**Soft Computing Techniques in Solar PV**	Soft Computing Techniques in Solar PV MPPT Using Fuzzy Logic controller (FLC), Description and Design of FLC, Neural Networks for MPP Tracking, Algorithm for ANN Based MPPT, Neuro-Fuzzy Based MPPT Method, Fuzzy Neural Network Hybrids, Theoretical Background of ANFIS, Architecture of Adaptive NeuroFuzzy Inference System, Hybrid Learning Algorithm.	8	CO2
3	**Wind Energy**	Wind Energy Conversion Systems Wind Characteristics; Wind Turbine; Fixed-Speed Wind Turbines; Variable-Speed Wind Turbines; Components of WECS; Types of Wind Turbine Generators; Power Converter Topologies for Wind Turbine Generators: Permanent Magnet Synchronous Generators, Doubly Fed Induction Generators; Grid Connection.	8	CO3
4	**Soft Computing Techniques in Wind Energy**	Soft Computing Techniques in Wind Energy Conversion Systems Prediction of Wind Turbine Power Factor, Problem Formulation, Artificial Neural Networks, Adaptive Neuro-fuzzy Inference System (ANFIS), Description of Profile Types, Design of the ANN, ANFIS for Prediction of Power Factor, Estimation of the Optimal Power Factor, Pitch Angle Control, Fuzzy Logic Controllers, Genetic Algorithms, Genetic Algorithm Controller for Pitch Angle Control, Fuzzy Logic Based MPPT Controller.	8	CO4
5	**Hybrid Energy Systems**	Hybrid Energy Systems Need for Hybrid Energy System, Architecture of Solar-Wind Hybrid System, Small Domestic Power Grid Based on Hybrid Electrical Power, Small Industrial Power System Based on Hybrid Renewable Energy, Fuzzy Logic Controller for Hybrid Power System, Design Considerations, Intelligent Controller.	8	CO5

Reference Books:

1.S. Sumathi, L. Ashok Kumar, P. Surekha, “Solar PV and Wind Energy Conversion Systems”, Springer International Publishing, Switzerland, 2015.

2. Ashok Desai V., “Non-Conventional Energy”, Wiley Eastern Ltd., 1990.

3. Mittal K.M., “Non-Conventional Energy Systems”, Wheeler Publishing Co. Ltd., 1997.

4. Ramesh R., Kurnar K.U., “Renewable Energy Technologies”, Narosa Publishing House, New Delhi, 1997

5. B. H. Khan, “Non-Conventional Energy Resources”, TMH Education Private Ltd., New Delhi, 2009.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	2	1	1	3	3	1					3	3	2			
CO2	3	2	2	2	3	3	3						2	3	1			
CO3	3	2	2	1	1	3	3	1					2	3	3			
CO4	3	2	2	2	3	3	3						2	3	2			
CO5	3	3	3	3	3	3	2						2	3	1			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation