Name of Institute: Institute of Technology & Engineering
Name of Faculty:

Course code: EL0519
Course name: Elements of Electrical Design

Pre-requisites:

ELECTRICAL MACHINES

Credit points: 04

Offered Semester: V

Course coordinator (weeks 01 - 15)
Full name:
Department with siting location: 3rd floor, Bhawar Building
Telephone:
Email:
Consultation times: 9:00 a.m. to 5:00 p.m.

Course lecturer (weeks 01 - 15)
Full name:
Department with siting location: 3rd floor, Bhawar Building
Telephone:
Email:
Consultation times: 9:00 a.m. to 5:00 p.m.

Students will be contacted throughout the session via mail with important information relating to this course.

Course Objectives

By participating in and understanding all facets of this course a student will:

1. To understand the design of small electrical equipments like starters, field regulators & control panels.
2. To understand the design of transformer and ballast
3. To understand the design of electrical equipments

Course Outcomes (CO)

CO1: Explain the basic concepts of Machine Design
CO2: Classify and compare different types of armature windings
CO3: Apply the general concepts and constraints in design of various electrical machines

CO4: Analyze the effect of dimensions of the different parts of various electrical machines on the output and losses
CO5: Design electrical equipment based on certain specification
CO6: Evaluate the performance of the new system designed.

Method of delivery

Face to face lectures, Assignments, Quiz

Study time

3-hour lecture and 1-hour tutorial per week

CO-PO Mapping (PO: Program Outcomes)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3			1								
CO2	3			2								
CO3	2	3		1								
CO4	2	3			1							
CO5	1	2	3			1						
CO6	1	1	3									

1-Lightly Mapped 2- Moderately Mapped 3- Highly Mapped

Blooms Taxonomy and Knowledge retention (For reference)

(Blooms taxonomy has been given for reference)

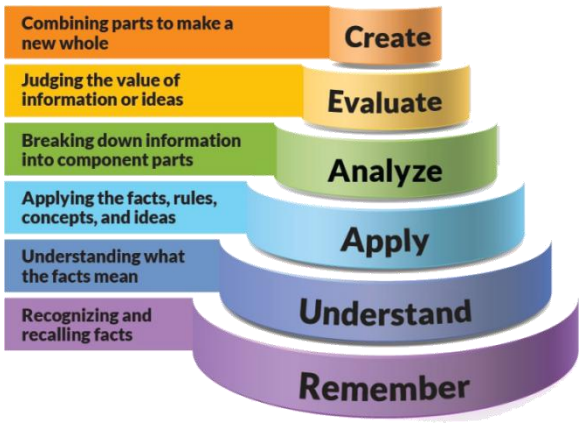


Figure 1: Blooms Taxonomy

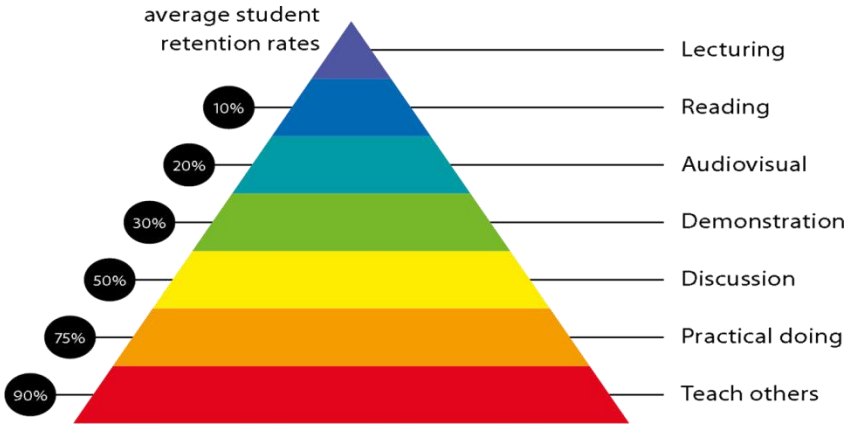


Figure 2: Knowledge retention

Graduate Qualities and Capabilities covered

(Qualities graduates harness crediting this Course)

General Graduate Qualities	Specific Department of _____Graduate Capabilities
Informed Have a sound knowledge of an area of study or profession and understand its current issues, locally and internationally. Know how to apply this knowledge. Understand how an area of study has developed and how it relates to other areas.	**1 Professional knowledge, grounding & awareness**
Independent learners Engage with new ideas and ways of thinking and critically analyze issues. Seek to extend knowledge through ongoing research, enquiry and reflection. Find and evaluate information, using a variety of sources and technologies. Acknowledge the work and ideas of others.	**2 Information literacy, gathering & processing**
Problem solvers Take on challenges and opportunities. Apply creative, logical and critical thinking skills to respond effectively. Make and implement decisions. Be flexible, thorough, innovative and aim for high standards.	**4 Problem solving skills**
Effective communicators Articulate ideas and convey them effectively using a range of media. Work collaboratively and engage with people in different settings. Recognize how culture can shape communication.	**5 Written communication** **6 Oral communication** **7 Teamwork**
Responsible Understand how decisions can affect others and make ethically informed choices. Appreciate and respect diversity. Act with integrity as part of local, national, global and professional communities.	**10 Sustainability, societal & environmental impact**

Practical work:
NA
Lecture/tutorial times
(Give lecture times in the format below)

Attendance Requirements

The University norms states that it is the responsibility of students to attend all lectures, tutorials, seminars and practical work as stipulated in the course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for semester examinations.

Details of referencing system to be used in written work

Text books

1. Electrical Estimating & Costing by N. Alagappan & S. Ekambaram (TTTI, Madras) - (Tata mcgrawhill Ltd).
2. Electrical Estimating & Costing by Surjit Singh (Dhanpat Rai & sons).
3. Elements of Electrical Design by Dr. J G Jamnani

Additional Materials

1. Electrical Machine Design by A. K. Shawney, Dhanpatrai & sons. Pub.
2. Electrical Installation, Estimating & Costing By J.B. Gupta (S.K.Kataria & Sons).
3. Electrical Machine Design by S. K. Sen, Oxford Publications.
4. Electrical Design, Estimating & Costing By K.B.Raina & S.K.Bhattacharya (TTTI, Chandigarh) – (Wiley Eastern Ltd.).

Web Resource

NA

MOOCS:

i) https://www.edx.org/
ii) https://www.nptel.ac.in/
iii) https://www.coursera.org/

ASSESSMENT GUIDELINES

Your final course mark will be calculated from the following:

SUPPLEMENTARY ASSESSMENT

Students who receive an overall mark less than 40% in internal component or less than 40% in the end semester will be considered for supplementary assessment in the respective components (i.e internal component or end semester) of semester concerned. Students must make themselves available during the supplementary examination period to take up the respective components (internal component or end semester) and need to obtain the required minimum 40% marks to clear the concerned components.

Practical Work Report/Laboratory Report:

A report on the practical work is due the subsequent week after completion of the class by each group.

Late Work

Late assignments will not be accepted without supporting documentation. Late submission of the reports will result in a deduction of -% of the maximum mark per calendar day

Format

All assignments must be presented in a neat, legible format with all information sources correctly referenced. **Assignment material handed in throughout the session that is not neat and legible will not be marked and will be returned to the student.**

Retention of Written Work

Written assessment work will be retained by the Course coordinator/lecturer for two weeks after marking to be collected by the students.

University and Faculty Policies

Students should make themselves aware of the University and/or Faculty Policies regarding plagiarism, special consideration, supplementary examinations and other educational issues and student matters.

Plagiarism - Plagiarism is not acceptable and may result in the imposition of severe penalties. Plagiarism is the use of another person's work, or idea, as if it is his or her own - if you have any doubts at all on what constitutes plagiarism, please consult your Course coordinator or lecturer. Plagiarism will be penalized severely.

Do not copy the work of other students.
Do not share your work with other students (except where required for a group activity or assessment

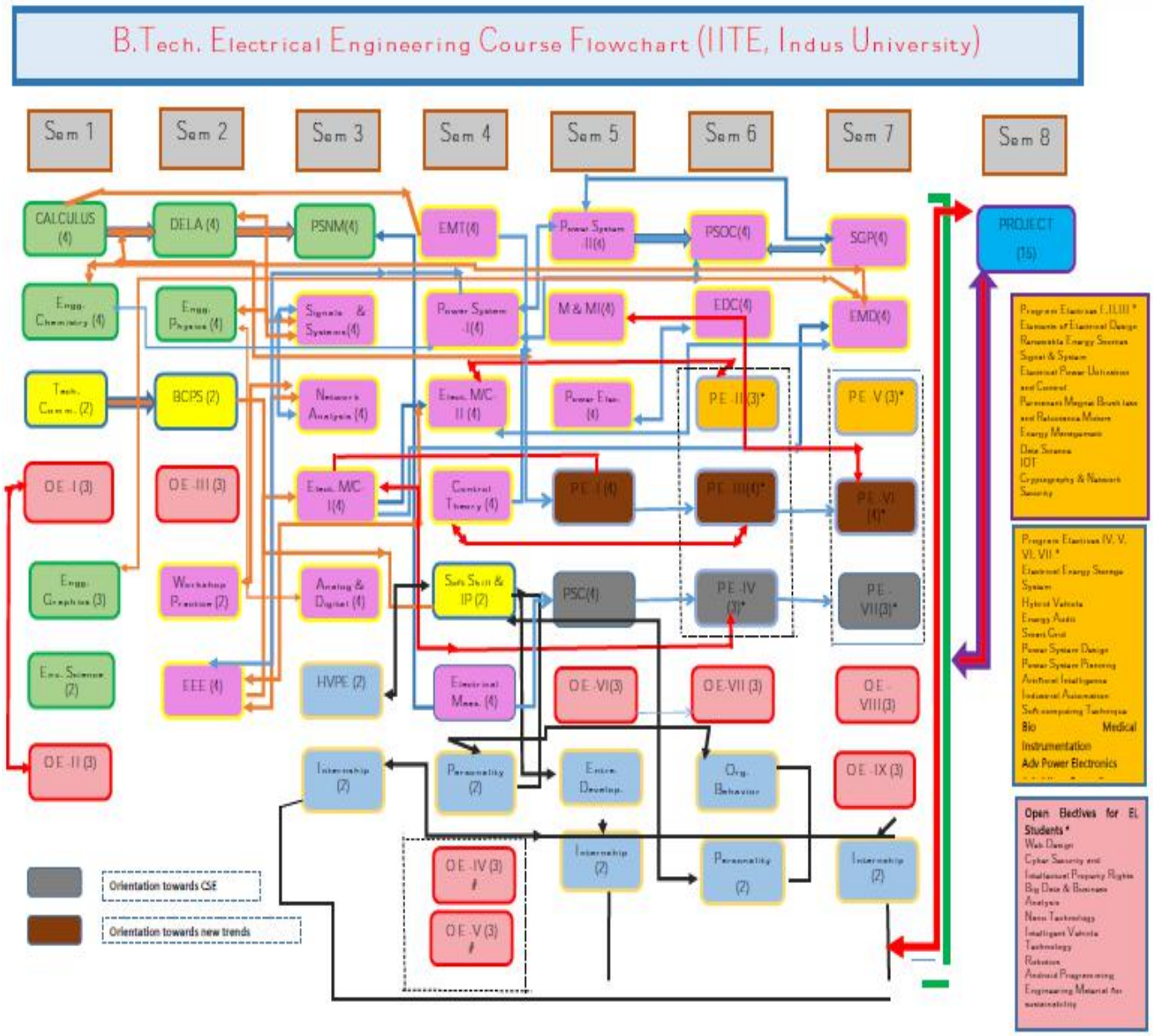
Course schedule (subject to change)

(Mention quiz, assignment submission, breaks etc as well in the table under the Teaching Learning Activity Column)

	Week #	Topic & contents	CO Addressed	Teaching Learning Activity (TLA)
	Weeks 1	Basic principles of magnetic circuits – use of B-H curves in magnetic circuits – Calculations of MMF for air gap and teeth – Real and apparent flux density		BB
	Weeks 2	Basic principles of magnetic circuits – use of B-H curves in magnetic circuits – Calculations of MMF for air gap and teeth – Real and apparent flux density		BB
	Week 3	Effect of saturation – flux density distribution -calculation of magnetizing current – Field Form – Introduction – carter's fringe curves – flux plotting – air gap flux distribution factor (field form factor) – actual flux distribution factor.		BB
	Week 4	Effect of saturation – flux density distribution -calculation of magnetizing current – Field Form – Introduction – carter's fringe curves – flux plotting – air gap flux distribution factor (field form factor) – actual flux distribution factor.		BB
	Week 5	Grading of starting resistance for DC shunt motor, DC series motor , Determination of the size of resistance element, field regulator in case of DC shunt motor and DC shunt generator, design problem, and control panels.		BB

	Week 6	Grading of starting resistance for DC shunt motor, DC series motor , Determination of the size of resistance element, field regulator in case of DC shunt motor and DC shunt generator, design problem, and control panels.		BB
	Week 7	Back emf starter, Time delay starter, DOL Starter, Primary resistance starter, Auto transformer starter, Star-Delta starter, Rotor Resistance starter		BB
	Week 8	esign of Small single-phase transformers — Design of variable air gap single-phase choke coil. Design of variable air gap three-phase choke coil. Design of ballast.		BB
	Week 9	Types of load, Electrical Supply Systems, Wiring systems, Load Assessment, Permissible voltage drops & Conductor size calculations, Control panel, Illumination Schemes.		BB
	Week 10	Tenaments , Row houses , Internal Wiring Estimation (Length of wire) Commercial Complexes. Internal Wiring Estimation (Length of wire).		BB
	Week 11	Simplex & Duplex windings, Lap & Wave windings, Applications, Basic terms related to armature windings, Dummy Coils, Equalizer connections, split coils.		BB
	Week 12	Simplex & Duplex windings, Lap & Wave windings, Applications, Basic terms related to armature windings, Dummy Coils, Equalizer connections, split coils.		BB
	Week 13	Introduction, No. of phases, Phase spread, concentric winding, Mush		BB

		winding, Double layer windings.		
	Week 14	Design of Small single-phase transformers — Design of variable air gap single-phase choke coil. Design of variable air gap three-phase choke coil. Design of ballast.		BB
	Week 15	Revision		BB


B.Tech. Electrical Engineering Course Flowchart (IITE, Indus University)
Sem 1
Sem 2
Sem 3
Sem 4
Sem 5
Sem 6
Sem 7
Sem 8
CALCULUS (4)
DELA (4)
PSNM(4)
EMT(4)
Power System -II(4)
PSOC(4)
SCP(4)
PROJECT (15)
Engg. Chemistry (4)
Engg. Physics (4)
Signals & Systems(4)
Power System -I(4)
M & MI(4)
EDC(4)
EMD(4)
Tech. Comm. (2)
BCPS (2)
Network Analysis (4)
Elect. MIC-II (4)
Power Elec. (4)
PE -II(3)*
PE -V (3)*
OE -I (3)
OE -III (3)
Elect. MIC I(4)
Control Theory (4)
PE -I (4)
PE -III(4)*
PE -VI (4)*
Engg. Graphics (3)
Workshop Practices (2)
Analog & Digital (4)
Soft Skill & IP (2)
PSC(4)
PE -IV (3)*
PE -VII(3)*
Env. Science (2)
EEE (4)
HVPE (2)
Electrical Meas. (4)
OE -VI(3)
OE -VII (3)
OE -VIII(3)
OE -II (3)
Internship (2)
Personality (2)
Entre. Develop.
Org. Behavior
OE -IX (3)
OE -IV (3)
OE -V (3)
Internship (2)
Personality (2)
Internship (2)
Orientation towards CSE
Orientation towards new trends
Program Electives I, II, III *
Elements of Electrical Design
Renewable Energy Sources
Signal & System
Electrical Power Utilization and Control
Permanent Magnet Brush less and Reluctance Motors
Energy Management
Data Science
IOT
Cryptography & Network Security
Program Electives IV, V, VI, VII *
Electrical Energy Storage System
Hybrid Vehicle
Energy Audit
Smart Grid
Power System Design
Power System Planning
Artificial Intelligence
Industrial Automation
Soft computing Technique
Bio Medical Instrumentation
Adv Power Electronics
Open Electives for EL Students *
Web Design
Cyber Security and Intellectual Property Rights
Big Data & Business Analysis
Nano Technology
Intelligent Vehicle Technology
Robotics
Android Programming
Engineering Material for sustainability

Name of Institute: Institute of Technology & Engineering
Name of Faculty: Asst Prof. Hinal Shah

Course code: EL0517
Course name: Microprocessor & Micro controller Interfacing

Pre-requisites:

Analog & Digital Logic

Credit points: 04

Offered Semester: V

Course coordinator (weeks 01 - 15)
Full name: Hinal Shah
Department with siting location: 3rd floor, Bhawar Building
Telephone: ext. 3335
Email: hinalshah.el@indusuni.ac.in
Consultation times: 9:00 a.m. to 5:00 p.m.

Course lecturer (weeks 01 - 15)
Full name: Hinal Shah
Department with siting location: 3rd floor, Bhawar Building
Telephone: ext. 3335
Email: hinalshah.el@indusuni.ac.in
Consultation times: 9:00 a.m. to 5:00 p.m.

Students will be contacted throughout the session via mail with important information relating to this course.

Course Objectives

By participating in and understanding all facets of this course a student will:

1. To get the overview of different families of microcontroller.
2. To understand the Assembly and c programming for 8 bit controller.
3. To understand the peripheral of 8051 microcontroller.
4. To learn the interfacing and application of microcontroller.

Course Outcomes (CO)

CO1: Describe the difference between Microprocessor and Micro controller. [BT-2]

CO2: Classify and compare architecture of 8051 family micro controllers.[BT-4]

CO3: Develop logic and simulate assembly program of 8051.[BT-6]

CO4: Develop and analyse embedded C Programming of 8051.[BT-6]

CO5: Apply and demonstrate micro controller peripheral operation.[BT-3]

CO6: Design and test embedded applications using Micro controller.[BT-6]

Course Outline

In this course Microprocessor & Micro controller architecture and its application is discussed. In this course assembly and embedded c language are also introduce.

UNIT-I [12]

Microprocessor System Architecture

Introduction, Registers, concept of address and data buses, system, control signals, basic bus timing, memory (RAM, ROM), input output devices, Microcomputer systems, over view of 8-16-32 bit Microprocessor and microcontroller family. Bus and instruction timing diagram, de-multiplexing of buses, generation of control signals.

The 8051 Microcontroller Architecture

Introduction to 8051 family microcontrollers, hardware architecture, input/output pins, I/O ports and circuits, on chip ram, general purpose registers, special function registers.

UNIT-II [11]

Assembly Language Programming of 8051

Concept of IDE (assembler, compiler, linker, de-bugger), addressing modes, data move instructions, arithmetic and logical instructions, jump, loop and call instructions, Bit addressable instructions and special instructions concept of timers-counters and interrupt.

UNIT-III [11]

Programming In Embedded C

Introduction, Date types in embedded C, arithmetic and logical operators, Control statements and loops in embedded C, Functions and Arrays in embedded C. Programming of input/ output ports, Programming of Timer & counters, writing interrupt service routines in Embedded C, concepts of subroutines, interrupt service routine

UNIT-IV [11]

8051 Interfacing

Concept of Serial Communication, 8051 interfacing and programming of UART in embedded C. Introduction, Interfacing and C programming of 8051 with keyboard, Interfacing and C programming of 8051 with 7-segment display, Interfacing and C programming of 8051 with LCD display, Interfacing and C programming of 8051 with ADC-DAC and sensors.

Method of delivery

Face to face lectures, Assignments, Quiz

Study time

3-hour lecture and 2-hour laboratory per week

CO-PO Mapping (PO: Program Outcomes)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	1	-	-	-	-	-	-	-
CO3	1	3	3	2	-	-	-	-	-	-	-	-
CO4	1	3	3	3	2	-	-	-	2	-	-	-
CO5	2	3	3	2	3	-	-	-	2	-	-	-
CO6	-	3	3	2	3	-	-	-	2	-	-	-
EL0517	**2**	**2.7**	**3**	**2.3**	**2.3**	**-**	**-**	**-**	**2**	**-**	**-**	**-**

1-Lightly Mapped 2- Moderately Mapped 3- Highly Mapped

Blooms Taxonomy and Knowledge retention (For reference)

(Blooms taxonomy has been given for reference)

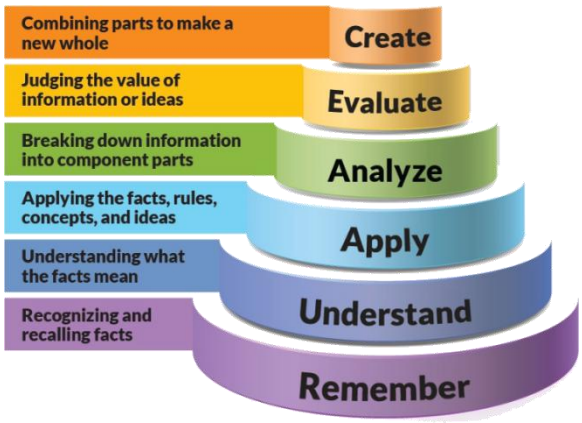


Figure 1: Blooms Taxonomy

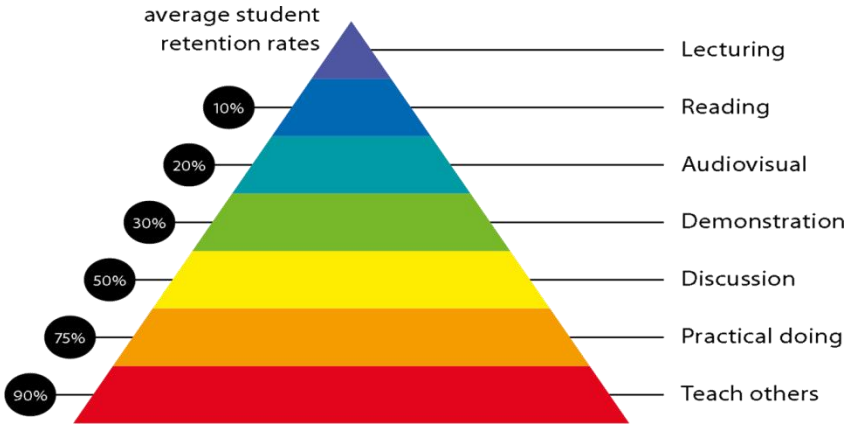


Figure 2: Knowledge retention

Graduate Qualities and Capabilities covered

(Qualities graduates harness crediting this Course)

General Graduate Qualities	Specific Department of _____Graduate Capabilities
Informed Have a sound knowledge of an area of study or profession and understand its current issues, locally and internationally. Know how to apply this knowledge. Understand how an area of study has developed and how it relates to other areas.	**1 Professional knowledge, grounding & awareness**
Independent learners Engage with new ideas and ways of thinking and critically analyze issues. Seek to extend knowledge through ongoing research, enquiry and reflection. Find and evaluate information, using a variety of sources and technologies. Acknowledge the work and ideas of others.	**2 Information literacy, gathering & processing**
Problem solvers Take on challenges and opportunities. Apply creative, logical and critical thinking skills to respond effectively. Make and implement decisions. Be flexible, thorough, innovative and aim for high standards.	**4 Problem solving skills**
Effective communicators Articulate ideas and convey them effectively using a range of media. Work collaboratively and engage with people in different settings. Recognize how culture can shape communication.	**5 Written communication** **6 Oral communication** **7 Teamwork**
Responsible Understand how decisions can affect others and make ethically informed choices. Appreciate and respect diversity. Act with integrity as part of local, national, global and professional communities.	**10 Sustainability, societal & environmental impact**

Practical work:

1. Introduction to 8051 keil µ-vision4 Simulator and Trainer Kit.
2. Assembly Level Programming based on Arithmetic operation.
3. Assembly language programming based on data transfer and branch operation.
4. Assembly level programming based on data transfer, logical and branch operations.
5. Simulate Program based on Embedded C
6. Generate PWM using 8051 microcontroller.
7. Simulate program based on timer operations of 8051.
8. Interface 7-segment with 8051 microcontroller and Design BCD UP counter and display on 7-segment.
9. Simulate Program based on serial communication of 8051.
10. Simulate the program based on interrupt in 8051
11. Interface 16x2 LCD with 8051and perform programming of LCD.

Lecture/tutorial times

(Give lecture times in the format below)

Lecture

Monday 9:00-10:00am
Tuesday 10:00-11:00am
Wednesday 11:10am to 12:10pm

Lab

Wednesday 2:00 to 4:10 pm

Attendance Requirements

The University norms states that it is the responsibility of students to attend all lectures, tutorials, seminars and practical work as stipulated in the course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for semester examinations.

Details of referencing system to be used in written work

Text books

1. R.S.Gaonker, “Microprocessor Architecture, programming, and application”, wiley eastern limited.
2. Kenneth J. Ayala, “The 8051 Microcontroller”, Penram International 3rd edition.
3. M. Mazidi and others, “The 8051 Microcontroller and Embedded Systems”, PRENTICE Hall Of India, 3rd edition.

Additional Materials

1. Michael slater, "Microprocessor based Design", PRENTICE Hall Of India, 3rd edition.
2. B. Ram, "Fundamentals of microprocessors and microcomputers", Dhanpat Rai.

Web Resource

1. https://www.electronicshub.org/interfacing-7-segment-display-8051
2. http://www.circuitstoday.com/interfacing-seven-segment-display-to-8051
3. http://www.keil.com/dd/docs/datashts/intel/ism51.pdf
4. https://www.elprocus.com/difference-between-avr-arm-8051-and-pic-microcontroller/
5. http://www.zseries.in/embedded%20lab/8051%20microcontroller/difference%20between%20microprocessor%20and%20microcontroller.php#.Wz8P9NIza1s

MOOCS:

1. https://www.edx.org/
2. https://www.nptel.ac.in/
3. https://www.coursera.org/

ASSESSMENT GUIDELINES

Your final course mark will be calculated from the following:

Mid semester (40 marks)		
Assignment (10 marks)		
Innovative/Project/Presentation/Attendance (10 marks)		
Final exam (*closed book*)	**(40 marks)**	**Objectives (1-6)**

SUPPLEMENTARY ASSESSMENT

Students who receive an overall mark less than 40% in internal component or less than 40% in the end semester will be considered for supplementary assessment in the respective components (i.e internal component or end semester) of semester concerned. Students must make themselves available during the supplementary examination period to take up the respective components (internal component or end semester) and need to obtain the required minimum 40% marks to clear the concerned components.

Practical Work Report/Laboratory Report:

A report on the practical work is due the subsequent week after completion of the class by each group.

Late Work

Late assignments will not be accepted without supporting documentation. Late submission of the reports will result in a deduction of -% of the maximum mark per calendar day

Format

All assignments must be presented in a neat, legible format with all information sources correctly referenced. **Assignment material handed in throughout the session that is not neat and legible will not be marked and will be returned to the student.**

Retention of Written Work

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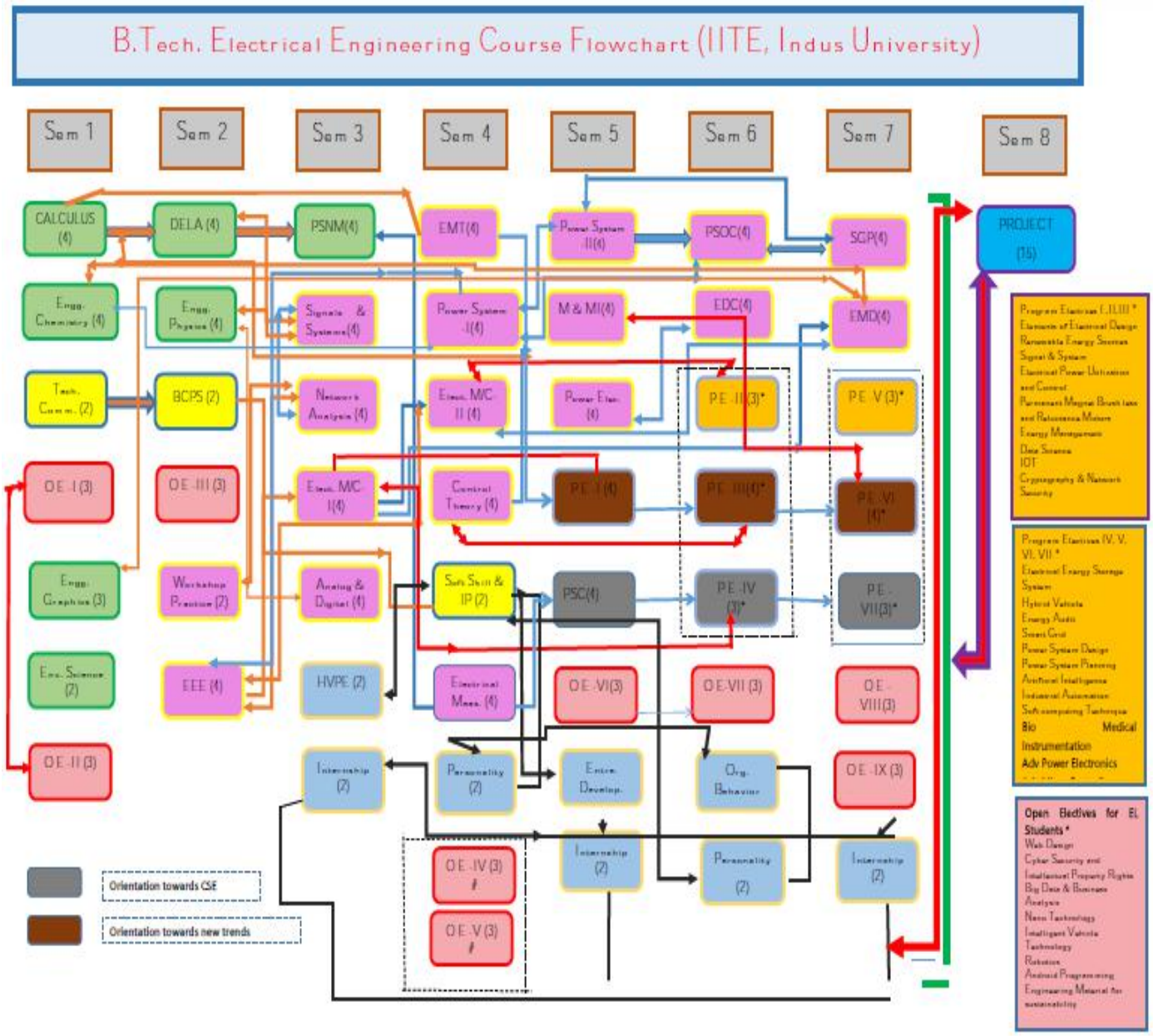
Do not copy the work of other students.
Do not share your work with other students (except where required for a group activity or assessment

Course schedule (subject to change)

(Mention quiz, assignment submission, breaks etc as well in the table under the Teaching Learning Activity Column)

	Week #	Topic & contents	CO Addressed	Teaching Learning Activity (TLA)
	Weeks 1	Introduction, Registers, concept of address and data buses, system, control signals, basic bus timing	1,2	BB
	Weeks 2	Memory (RAM, ROM), input output devices, de-multiplexing of buses, generation of control signals, Difference between processor and controller	1,2	BB
	Week 3	Overview of 8-16-32 bit Microprocessor and microcontroller family, 8051 family microcontrollers, hardware architecture, On chip ram, general purpose registers, special function registers.	1,2	BB
	Week 4	8051 Pin diagram and function of each pin, Oscillator and reset circuit, I/O ports and circuits.	1,2	BB
	Week 5	Concept of IDE (assembler, compiler, linker, de-bugger), Introduction to addressing modes, Data move Instructions	3	BB
	Week 6	Arithmetic and logical instructions, Jump and call instructions, Bit addressable Instructions	3	BB
	Week 7	Special Instructions, Assembly Programming	3	BB
	Week 8	Concept of Timer and Counters, Interrupt concept, Introduction to	3,4,5	BB

		embedded C, Date types in embedded C		
	Week 9	arithmetic and logical operators, Control statements and loops in embedded C, Functions and Arrays in embedded C.	4,5	BB
	Week 10	Programming of input/ output ports, Programming of Timers mode0, mode1, mode 2 & mode3, Programming of counters	4,5	BB
	Week 11	Interrupt service routines in Embedded C, External Interrupt service routine, Concept of subroutine and Interrupt service routine	4,5	BB
	Week 12	Embedded c programming, Concept of Serial Communication, 8051 interfacing and programming of UART in embedded C	5	BB
	Week 13	Interfacing of 8051 with LCD display, C programming of 8051 with LCD display, Interfacing of 8051 with ADC 0804 & C programming.	6	BB
	Week 14	Interfacing of 8051 with ADC 0809 & C programming, Interfacing and C programming of 8051 with DAC, Interfacing and C programming of 8051 with ADC- sensors.	6	BB
	Week 15	Interfacing and C programming of 8051 with 7-segment display, Interfacing of 8051 with keyboard, C programming of 8051 with keyboard	6	BB


B.Tech. Electrical Engineering Course Flowchart (IITE, Indus University)
Sem 1
Sem 2
Sem 3
Sem 4
Sem 5
Sem 6
Sem 7
Sem 8
CALCULUS (4)
DELA (4)
PSNM(4)
EMT(4)
Power System -II(4)
PSOC(4)
SCP(4)
PROJECT (15)
Engg. Chemistry (4)
Engg. Physics (4)
Signals & Systems(4)
Power System -I(4)
M & MI(4)
EDC(4)
EMD(4)
Tech. Comm. (2)
BCPS (2)
Network Analysis (4)
Elect. MIC-II (4)
Power Elec. (4)
PE -II(3)*
PE -V (3)*
OE -I (3)
OE -III (3)
Elect. MIC I(4)
Control Theory (4)
PE -I (4)
PE -III(4)*
PE -VI (4)*
Engg. Graphics (3)
Workshop Practices (2)
Analog & Digital (4)
Soft Skill & IP (2)
PSC(4)
PE -IV (3)*
PE -VII(3)*
Env. Science (2)
EEE (4)
HVPE (2)
Electrical Meas. (4)
OE -VI(3)
OE -VII (3)
OE -VIII(3)
OE -II (3)
Internship (2)
Personality (2)
Entre. Develop.
Org. Behavior
OE -IX (3)
OE -IV (3)
OE -V (3)
Internship (2)
Personality (2)
Internship (2)
Orientation towards CSE
Orientation towards new trends
Program Electives I, II, III *
Elements of Electrical Design
Renewable Energy Sources
Signal & System
Electrical Power Utilization and Control
Permanent Magnet Brush less and Reluctance Motors
Energy Management
Data Science
IOT
Cryptography & Network Security
Program Electives IV, V, VI, VII *
Electrical Energy Storage System
Hybrid Vehicle
Energy Audit
Smart Grid
Power System Design
Power System Planning
Artificial Intelligence
Industrial Automation
Soft computing Technique
Bio Medical Instrumentation
Adv Power Electronics
Open Electives for EL Students *
Web Design
Cyber Security and Intellectual Property Rights
Big Data & Business Analysis
Nano Technology
Intelligent Vehicle Technology
Robotics
Android Programming
Engineering Material for sustainability

Syllabus

Subject: Microprocessor & Microcontroller Interfacing								
Program: B.Tech. Electrical Engineering			**Subject Code:EL0517**				**Semester: V**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	0	2	4	40	40	60	60	200

Perquisites:

i) Digital Logic Design

Course Objectives:

(i) To understand the difference between microprocessor and microcontroller.

(ii) To understand the assembly language of 8051 and also develop logic

(iii) To know programming in embedded c with peripheral interfacing

(iv) To know application of microcontroller and its interfacing.

Course Outcome:

i) Know the microprocessor and Microcontroller difference.

ii) Getting familiar with the architecture of 8051 family microcontrollers.

iii) Learn the assembly language of 8051 and able to write program.

iv) Learn the embedded C language Programming of 8051.

v) Able to configure 8051 peripherals and its working.

vi) Learn the interfacing of microcontroller and based on that develop various Application using Microcontroller.

SYLLABUS

UNIT-I **[12]**

Microprocessor System Architecture

Introduction, Registers, concept of address and data buses, system, control signals, basic bus timing, memory (RAM, ROM), input output devices, Microcomputer systems, over view of 8-16-32 bit Microprocessor and microcontroller family. Bus and instruction timing diagram, de-multiplexing of buses, generation of control signals.

The 8051 Microcontroller Architecture

Introduction to 8051 family microcontrollers, hardware architecture, input/output pins, I/O ports and circuits, on chip ram, general purpose registers, special function registers.

UNIT-II **[11]**

Assembly Language Programming of 8051

Concept of IDE (assembler, compiler, linker, de-bugger), addressing modes, data move instructions, arithmetic and logical instructions, jump, loop and call instructions, Bit addressable instructions and special instructions concept of timers-counters and interrupt.

UNIT-III **[11]**

Programming In Embedded C

Introduction, Date types in embedded C, arithmetic and logical operators, Control statements and loops in embedded C, Functions and Arrays in embedded C. Programming of input/ output ports, Programming of Timer & counters, writing interrupt service routines in Embedded C, concepts of subroutines, interrupt service routine

UNIT-IV **[11]**

8051 Interfacing

Concept of Serial Communication, 8051 interfacing and programming of UART in embedded C. Introduction, Interfacing and C programming of 8051 with keyboard, Interfacing and C programming of 8051 with 7-segment display, Interfacing and C programming of 8051 with LCD display, Interfacing and C programming of 8051 with ADC-DAC and sensors.

Text Books

i) R.S.Gaonker, “Microprocessor Architecture, programming, and application”, wiley eastern limited.
ii) Kenneth J. Ayala, “The 8051 Microcontroller”, Penram International 3rd edition.
iii) M. Mazidi and others, “The 8051 Microcontroller and Embedded Systems”, PRENTICE Hall Of India, 3rf edition.

Reference Books

i) Michael slater, “Microprocessor based Design”, PRENTICE Hall Of India, 3rd edition.
ii) B. Ram, “Fundamentals of microprocessors and microcomputers”, Dhanpat Rai.

Web resources

i) http://www.zseries.in/embedded%20lab/8051%20microcontroller/difference%20between%20microprocessor%20and%20microcontroller.php#.Wz8P9NIza1s
ii) https://www.elprocus.com/difference-between-avr-arm-8051-and-pic-microcontroller/
iii) http://www.keil.com/dd/docs/datashts/intel/ism51.pdf
iv) https://www.electronicshub.org/interfacing-7-segment-display-8051/
v) http://www.circuitstoday.com/interfacing-seven-segment-display-to-8051

MOOCs

i) https://www.edx.org/

ii) https://www.nptel.ac.in/

iii) https://www.coursera.org/

Name of Institute: Institute of Technology & Engineering
Name of Faculty:

Course code: EL0525
Course name: Optimization Techniques

Pre-requisites:

i) Differential Equations
ii) Vector calculus
iii) Matrix Algebra

Credit points: 04

Offered Semester: IV

Course coordinator (weeks 01 - 15)
Full name: Dr. Jaydeep Chakravorty
Department with siting location: 3rd floor, Bhawar Building
Telephone:
Email: el.hod@indusuni.ac.in
Consultation times: 9:00 a.m. to 5:00 p.m.

Course lecturer (weeks 01 - 15)
Full name: Dr. Jaydeep Chakravorty
Department with siting location: 3rd floor, Bhawar Building
Telephone:
Email: el.hod@indusuni.ac.in
Consultation times: 9:00 a.m. to 5:00 p.m.

Students will be contacted throughout the session via mail with important information relating to this course.

Course Objectives

By participating in and understanding all facets of this course a student will:

(i) To understand different optimization techniques.
(ii) To learn the concept of system constraints.
(iii) To learn the concept of single variable optimization
(iv) To understand application of multivariable optimization.
(v) To understand the concept of linear programming.
(vi) To understand application of non linear programming.

Course Outcomes (CO)

CO 1: Able to apply concept of optimization.

CO 2: Able to determine optimal solution of single variable problem.

CO 3: To expose the ideas about constraint surface.

CO 4: Able to utilize multivariable optimization with given constraints.

CO 5: Analyze problems with linear programming methods.

CO 6: Analyze problems with non linear programming methods.

Course Outline

In this course students will learn about various optimization methods, which includes single and multi-variable optimization, linear and non linear programming, and also modern optimization techniques.

Method of delivery

Face to face lectures, Assignments, Quiz

Study time

3-Hour lecture per week

CO-PO Mapping (PO: Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	1	1	2	1	-	1	1	-	2
CO2	3	2	2	1	1	1	1	-	1	2	-	2
CO3	3	3	3	1	2	1	1	1	1	1	1	2
CO4	3	3	3	3	2	1	2	2	2	1	1	2
CO5	3	2	1	1	1	2	1	-	1	1	-	2
CO6	3	3	3	2	2	1	1	1	1	2	1	2

Blooms Taxonomy and Knowledge retention (For reference)

(Blooms taxonomy has been given for reference)

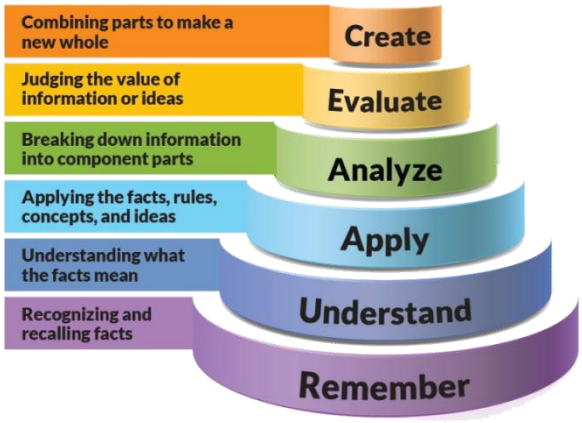


Figure 1: Blooms Taxonomy

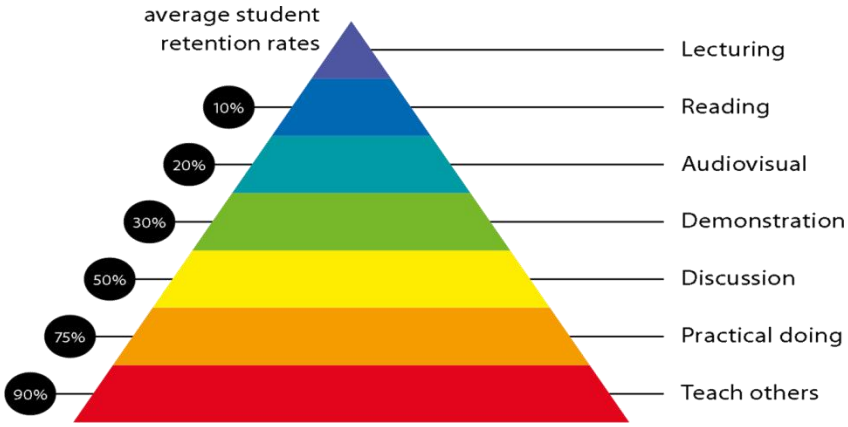


Figure 2: Knowledge retention

Graduate Qualities and Capabilities covered

(Qualities graduates harness crediting this Course)

General Graduate Qualities	Specific Department of _____Graduate Capabilities
Informed Have a sound knowledge of an area of study or profession and understand its current issues, locally and internationally. Know how to apply this knowledge. Understand how an area of study has developed and how it relates to other areas.	**1 Professional knowledge, grounding & awareness**
Independent learners Engage with new ideas and ways of thinking and critically analyze issues. Seek to extend knowledge through ongoing research, enquiry and reflection. Find and evaluate information, using a variety of sources and technologies. Acknowledge the work and ideas of others.	**2 Information literacy, gathering & processing**
Problem solvers Take on challenges and opportunities. Apply	**4 Problem solving skills**

creative, logical and critical thinking skills to respond effectively. Make and implement decisions. Be flexible, thorough, innovative and aim for high standards.	
Effective communicators Articulate ideas and convey them effectively using a range of media. Work collaboratively and engage with people in different settings. Recognize how culture can shape communication.	**5 Written communication** **6 Oral communication** **7 Teamwork**
Responsible Understand how decisions can affect others and make ethically informed choices. Appreciate and respect diversity. Act with integrity as part of local, national, global and professional communities.	**10 Sustainability, societal & environmental impact**

Practical work:

N.A.

Lecture/tutorial times

Attendance Requirements

The University norms states that it is the responsibility of students to attend all lectures, tutorials, seminars and practical work as stipulated in the course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for semester examinations.

Details of referencing system to be used in written work

Text books

1. Engineering Optimization (Theory and Practice), by S S Rao, JOHN WILEY & SONS, INC, 4th Edition, 2019

Additional Materials

2. Taha,H.A., Operations Research –An Introduction, Prentice Hall of India,2003.

3. Fox, R.L., „Optimization methods for Engineering Design", Addition Welsey, 1971

Web Resource

1. nptel.ac.in/courses/105108127/pdf/Module_1/M1L2_LN.pdf
2. www.nptel.ac.in/courses/105108127/pdf/Module_1/M1L4_LN.pdf

MOOCS:

i) https://www.edx.org/

ii) https://www.nptel.ac.in/

iii) https://www.coursera.org/

ASSESSMENT GUIDELINES

Your final course mark will be calculated from the following:

SUPPLEMENTARY ASSESSMENT

Students who receive an overall mark less than 40% in internal component or less than 40% in the end semester will be considered for supplementary assessment in the respective components (i.e internal component or end semester) of semester concerned. Students must make themselves available during the supplementary examination period to take up the respective components (internal component or end semester) and need to obtain the required minimum 40% marks to clear the concerned components.

Practical Work Report/Laboratory Report:

N.A.

Late Work

Late assignments will not be accepted without supporting documentation. Late submission of the reports will result in a deduction of -% of the maximum mark per calendar day

Format

All assignments must be presented in a neat, legible format with all information sources correctly referenced. **Assignment material handed in throughout the session that is not neat and legible will not be marked and will be returned to the student.**

Retention of Written Work

Written assessment work will be retained by the Course coordinator/lecturer for two weeks after marking to be collected by the students.

University and Faculty Policies

Students should make themselves aware of the University and/or Faculty Policies regarding plagiarism, special consideration, supplementary examinations and other educational issues and student matters.

Plagiarism - Plagiarism is not acceptable and may result in the imposition of severe penalties. Plagiarism is the use of another person's work, or idea, as if it is his or her own - if you have any doubts at all on what constitutes plagiarism, please consult your Course coordinator or lecturer. Plagiarism will be penalized severely.

Do not copy the work of other students.
Do not share your work with other students (except where required for a group activity or assessment)

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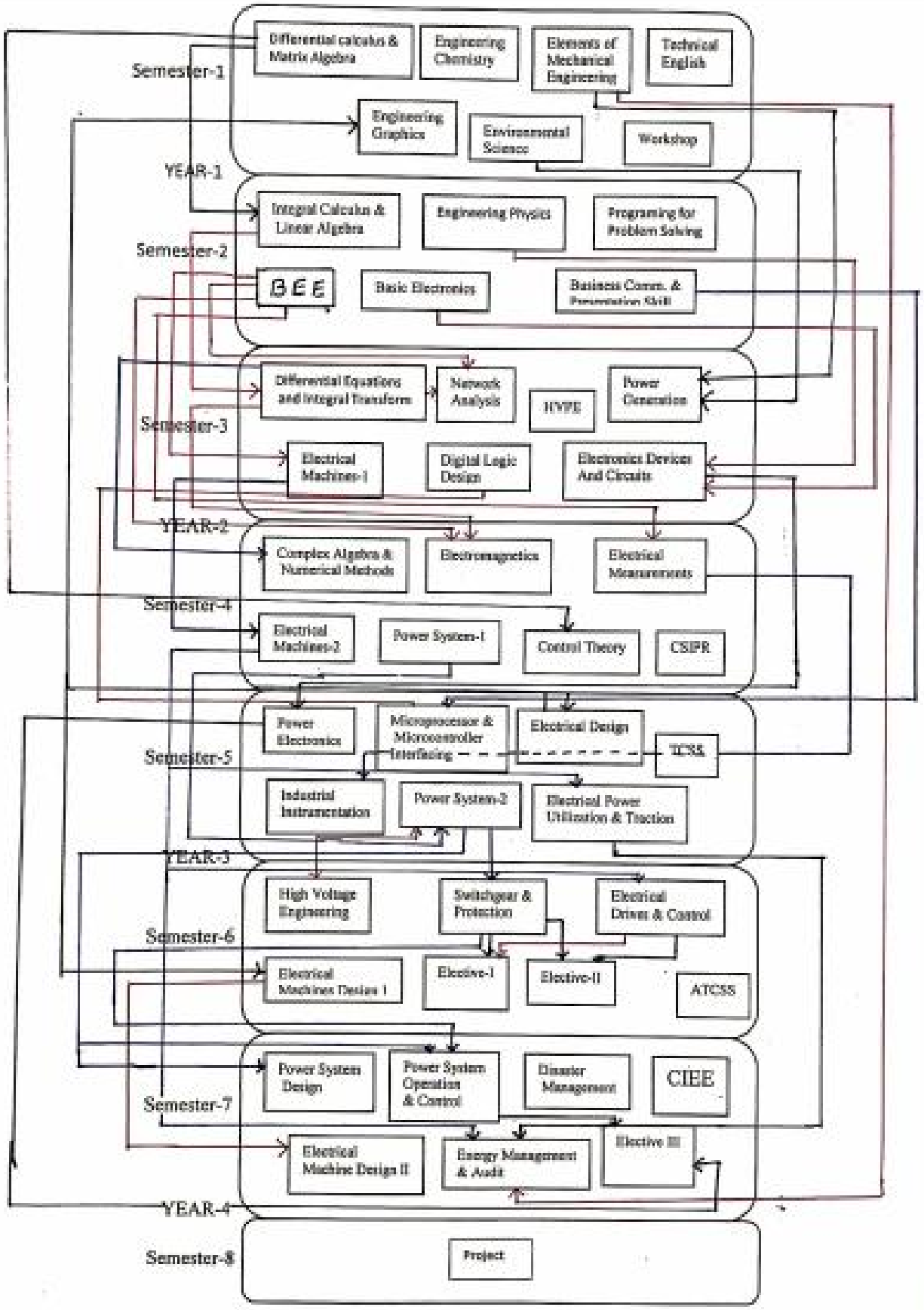
Course schedule (subject to change)

(Mention quiz, assignment submission, breaks etc as well in the table under the Teaching Learning Activity Column)

	Week #	Topic & contents	CO Addressed	Teaching Learning Activity (TLA)
	Weeks 1	Goals of optimization, classical optimization method, Numerical methods	2	BB
	Weeks 2	Advanced optimization Techniques, Hill climbing, simulated annealing, Ant colony algorithm	1	BB
	Week 3	Genetic Algorithm, Neural Network,	*1*	BB
	Week 4	Fuzzy logic, schematic of optimization process.	1	BB
	Week 5	System constraints, constraint surface, classification of optimization, global minima, local minima, necessary and sufficient condition	2	BB
	Week 6	Multi variable optimization with no constraints, saddle point, direct substitution method,	*2*	BB
	Week 7	Constraint variation method, langrage multiplier method,	3,4	BB
	Week 8	Multi variable optimization with inequality constraints, Kuhn-tucker condition	4	BB
	Week 9	Simplex method, standard form of a linear programming, characteristic of a linear programming,	*3*	BB
	Week 10	Transformation of LP problems, Geometry of LP, Geometrical characteristics of the graphical solution of LP Problems,	5	BB
	Week 11	Product mix problem, Blending problem, Production scheduling problem, Transportation problem,	5	BB

		Duality.		
	Week 12	One dimensional minimization methods, Unimodal function, Exhaustive search, Dichotomous search,	5	BB
	Week 13	Interval halving method, Fibonacci method, Golden Section Method	5,6	BB
	Week 14	Interpolation methods, Quadratic Interpolation Method,	6	BB
	Week 15	Newton Method , Quasi-Newton Method.	6	BB



Elective-I: Advanced Control Theory, Industrial Automation, Soft Computing
Elective-II: Electrical Power Quality, EHV AC & DC, Special Machines, MOOC
Elective-III: FACTS, Advanced Power Electronics, Power System Planning, MOOC

Subject: Optimization Techniques								
Program: B.Tech. Electrical Engineering				**Subject Code: EL0525**				**Semester: V**
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	1	0	4	40	0	60	0	100

Perquisites:

iv) Differential Equation

v) Vector calculus, Matrix Algebra

Course Objective:

(vii) To understand different optimization techniques.

(viii) To learn the concept of system constraints.

(ix) To learn the concept of single variable optimization

(x) To understand application of multivariable optimization.

(xi) To understand the concept of linear programming.

(xii) To understand application of non linear programming.

Course Outcome:

CO-1: Able to define and recall various concept of optimization. [BT-1]

CO-2: Able to describe about the optimal solution of single variable problem. [BT-2]

CO-3: Able to apply the ideas about constraint surface. [BT-3]

CO-4: Able to analyze multivariable optimization with given constraints. [BT-4]

CO-5: Evaluate problems with linear programming methods. [BT-5]

CO-6: Design problems with non linear programming methods, which will help in developing employability skills [BT-6]

SYLLABUS

UNIT-I **[12]**

Introduction

Goals of optimization, classical optimization method, Numerical methods, Advanced optimization Techniques, Hill climbing, simulated annealing, Ant colony algorithm, Genetic Algorithm, Neural Network, Fuzzy logic, schematic of optimization process.

UNIT-II **[12]**

Single Variable and Multi variable Optimization

System constraints, constraint surface, classification of optimization, global minima, local minima, necessary and sufficient condition, Multi variable optimization with no constraints, saddle point, direct substitution method, constraint variation method, langrage multiplier method, multi variable optimization with inequality constraints, Kuhn-tucker condition

UNIT-III **[10]**

Linear Programming

Simplex method, standard form of a linear programming, characteristic of a linear programming, Transformation of LP problems, Geometry of LP, Geometrical characteristics of the graphical solution of LP Problems, Product mix problem, Blending problem, Production scheduling problem, Transportation problem, Duality.

UNIT-IV **[11]**

Non Linear Programming

One dimensional minimization methods, Unimodal function, Exhaustive search, Dichotomous search, Interval halving method, Fibonacci method, Golden Section Method, Interpolation methods, Quadratic Interpolation Method, Newton Method , Quasi-Newton Method.

Text books:

1. Rao,S.S., Optimization :Theory and Application" Wiley Eastern Press, 2nd edition 1984.

Reference Book

2. Taha,H.A., Operations Research –An Introduction, Prentice Hall of India,2003.

3. Fox, R.L., „Optimization methods for Engineering Design", Addition Welsey, 1971

Web Resource

nptel.ac.in/courses/105108127/pdf/Module_1/M1L2_LN.pdf

www.nptel.ac.in/courses/105108127/pdf/Module_1/M1L4_LN.pdf

MOOCS:

iv) https://www.edx.org/

v) https://www.nptel.ac.in/

https://www.coursera.org/

Name of Institute: Institute of Technology & Engineering

Name of Faculty:

Course code: EL0526

Course name: Power Electronics

Pre-requisites:

1) Basics of electrical and electronics circuits.
2) Basics of semiconductor devices and circuits

Credit points: 04

Offered Semester: V

Course coordinator (weeks 01 - 15)

Full name: Prof. Rashmi Sharma

Department with siting location: 2nd floor, Bhawar Building

Telephone: 3212

Email: rashmisharma.el@indusuni.ac.in

Consultation times: 9:00 a.m. to 5:00 p.m.

Course lecturer (weeks 01 - 15)

Full name: Prof. Rashmi Sharma

Department with siting location: 2nd floor, Bhawar Building

Telephone: 3212

Email: rashmisharma.el@indusuni.ac.in

Consultation times: 9:00 a.m. to 5:00 p.m.

Students will be contacted throughout the session via mail with important information relating to this course.

Course Objectives

By participating in and understanding all facets of this course a student will:

1. To learn different types of power semiconductor devices, its circuit configuration and characteristics.
2. To learn ac-dc converters circuits, its operation and its control characteristics.
3. To learn power factor improvement techniques and the applications of ac-dc converters

4. To learn dc-ac converters circuits, its operation and its commutation techniques.
5. To learn pulse width modulation techniques and its operation.
6. To learn ac-ac converters and dc-dc converters types, and control characteristics.

Course Outcomes (CO)

CO-1: Explain the basic types of semiconductor devices, control and its applications in different areas.

CO-2: Understand the operation and control characteristics of ac-dc converters.

CO-3: Analyze and calculate the different circuit configurations, gating requirements of the different types of converters.

CO-4: Analyze the operation and control, the different circuits and operating parameters of the of dc-ac and ac-ac converters.

CO-5: Understand power factor improvement and pulse width modulation techniques.

CO-6: Analyze the operation and control, the different circuits and the operating parameters of the of ac voltage converters and dc-ac converters.

Course Outline

In this course different power semiconductor devices and converters like ac-dc ,dc-ac, ac-ac and dc-dc configuration, their operation and performance will be studied. Also, power factor improvement and pulse width modulation techniques and their applications in electrical engineering will be studied.

Method of delivery

Face to face lectures, Assignments, Quiz

Study time

3-hour lecture and 2-hour practical per week

CO-PO Mapping (PO: Program Outcomes)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	3	2	2	1	2	1	-	-	-	-	-	1
CO2	3	3	2	1	1	1	-	-	-	-	-	-
CO3	2	3	3	2	2	1	-	-	-	-	-	-
CO4	3	2	3	2	2	1	-	-	-	-	-	-

CO5	3	2	2	1	1	1	-	-	-	-	-	1
CO6	3	2	2	2	2	1	-	-	-	-	1	-

Blooms Taxonomy and Knowledge retention(For reference)

(Blooms taxonomy has been given for reference)

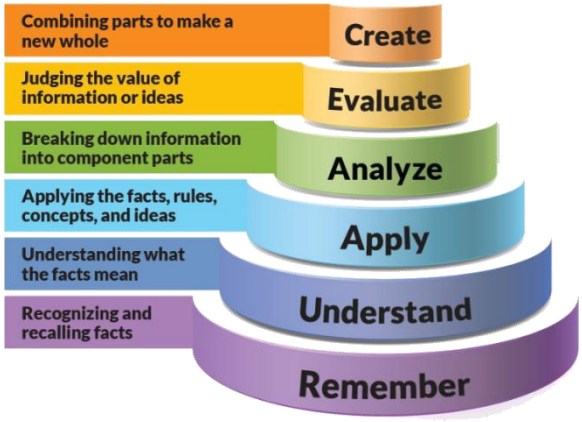


Figure 1: Blooms Taxonomy

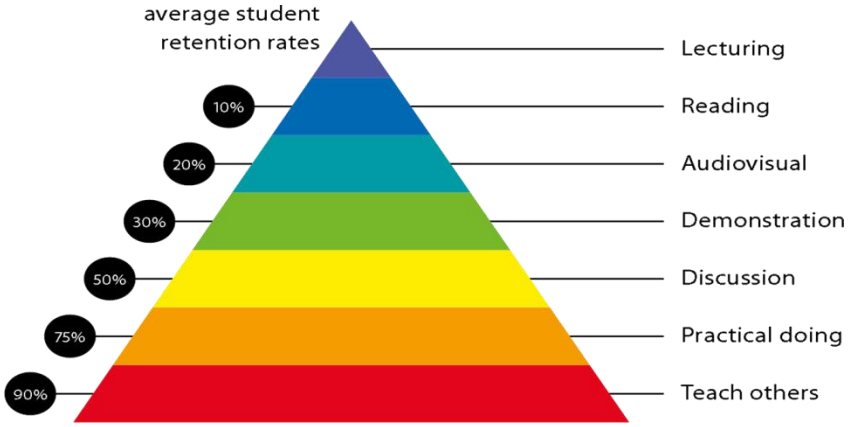


Figure 2: Knowledge retention

Graduate Qualities and Capabilities covered

(Qualities graduates harness crediting this Course)

General Graduate Qualities	Specific Department of _____Graduate Capabilities
Informed Have a sound knowledge of an area of study or profession and understand its current issues, locally and internationally. Know how to apply this knowledge. Understand how an area of	**1 Professional knowledge, grounding & awareness**

study has developed and how it relates to other areas.	
Independent learners Engage with new ideas and ways of thinking and critically analyze issues. Seek to extend knowledge through ongoing research, enquiry and reflection. Find and evaluate information, using a variety of sources and technologies. Acknowledge the work and ideas of others.	**2 Information literacy, gathering & processing**
Problem solvers Take on challenges and opportunities. Apply creative, logical and critical thinking skills to respond effectively. Make and implement decisions. Be flexible, thorough, innovative and aim for high standards.	**4 Problem solving skills**
Effective communicators Articulate ideas and convey them effectively using a range of media. Work collaboratively and engage with people in different settings. Recognize how culture can shape communication.	**5 Written communication** **6 Oral communication** **7 Teamwork**
Responsible Understand how decisions can affect others and make ethically informed choices. Appreciate and respect diversity. Act with integrity as part of local, national, global and professional communities.	**10 Sustainability, societal & environmental impact**

Practical work:

2 hours per week laboratory hands-on session

Lecture/tutorial times

Atte

The University norms states that it is the responsibility of students to attend all lectures, tutorials, seminars and practical work as stipulated in the course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for semester examinations.

Details of referencing system to be used in written work

Text books

1. Bimbhra, P. S., "Power electronics", Khanna Publishers, New Delhi, 2001
2. Rashid, M. H., " Power Electronics Circuits, Devices, and Applications, Prentice-Hall of India Pvt. Ltd., New Delhi, 2nd edition, 1999.
3. Singh, M. D., Khanchandani, K. B "Power electronics", Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2001.

Additional Materials

1. Ned Mohan, Tore M. Undeland and William P. Robbins, “Power Electronics Converters, Applications, and Design”, John Willey & Sons, Inc., 2ndEdition, 1995.
2. Agrawal, J. P., "Power electronic systems: Theory and design" Addison Wesley Longman (Singapore) Pte. Ltd. New Delhi, 2001
3. Boylestad R. and Nashelsky L., “Electronic Devices and Circuit Theory”, 9th Ed., Prentice Hall of India Private Limited. 2008
4. Gayakward R. A., “ OP-AMPs and Linear Integrated Circuit Technology ” , 4th Ed., Pearson Education. 2008
5. Dubey G. K., Doradla S. R., Joshi A. and Sinha R. M. K., Thyristorised Power Controllers”, New Age International Private Limited. 2008

Web Resource:

1. https://www.youtube.com/watch?v=PEg0zb3cg2A
2. https://www.youtube.com/watch?v=-X2ETVLpAA4
3. https://www.youtube.com/watch?v=n2P1NH0wXZk
4. https://www.youtube.com/watch?v=R-ZGu5KAF90

MOOCS:

1. https://www.edx.org/

2. https://www.nptel.ac.in/
3. https://www.coursera.org/

ASSESSMENT GUIDELINES

Your final course mark will be calculated from the following:

Theory

CIE 60 marks (40 marks mid semester examination + 20 marks internal evaluation)

Components of internal evaluation
05 marks as attendance bonus for all students having attendance > 80%
05 marks for presentation
10 marks for assignment or case studies

Laboratory

File Work (10 marks)
Lab Participation (20 marks)
Project / Presentation (20 marks)
Viva – Voice (10 marks)

End Term Examination: 40 marks

SUPPLEMENTARY ASSESSMENT

Students who receive an overall mark less than 40% in internal component or less than 40% in the end semester will be considered for supplementary assessment in the respective components (i.e internal component or end semester) of semester concerned. Students must make themselves available during the supplementary examination period to take up the respective components (internal component or end semester) and need to obtain the required minimum 40% marks to clear the concerned components.

Practical Work Report/Laboratory Report:

Practical work-related lab file/manual to be made by the student on completion of each experiment. The list of experiments are given below:

1. To study the operation of resistance and resistance capacitance triggering circuits.
2. To perform phase control of SCR by UJT with pedestal and Ramp method.
3. To plot the four modes of TRIAC characteristics.
4. To plot the four modes of TRIAC and DIAC characteristics.
5. To plot phase control of TRIAC by light dimmer control & measure the holding & latching current.

6. To plot the V-I characteristics of S.C.R
7. To draw static characteristic of MOSFET
8. To plot the characteristics of IGBT.
9. To study operation of Full Controlled Half Wave Rectifier
10. To observe the response of single-phase parallel inverter with resistive and reactive Load.
11. To observe and generate a PWM signal using Op-Amp and 555 Timer.
12. To study the operation of ac and dc drive in open and close loop mode.

Late Work

Late assignments will not be accepted without supporting documentation. Late submission of the reports will result in a deduction of -% of the maximum mark per calendar day

Format

All assignments must be presented in a neat, legible format with all information sources correctly referenced. **Assignment material handed in throughout the session that is not neat and legible will not be marked and will be returned to the student.**

Retention of Written Work

Written assessment work will be retained by the Course coordinator/lecturer for two weeks after marking to be collected by the students.

University and Faculty Policies

Students should make themselves aware of the University and/or Faculty Policies regarding plagiarism, special consideration, supplementary examinations and other educational issues and student matters.

Plagiarism - Plagiarism is not acceptable and may result in the imposition of severe penalties. Plagiarism is the use of another person's work, or idea, as if it is his or her own - if you have any doubts at all on what constitutes plagiarism, please consult your Course coordinator or lecturer. Plagiarism will be penalized severely.

Do not copy the work of other students.

Do not share your work with other students (except where required for a group activity or assessment

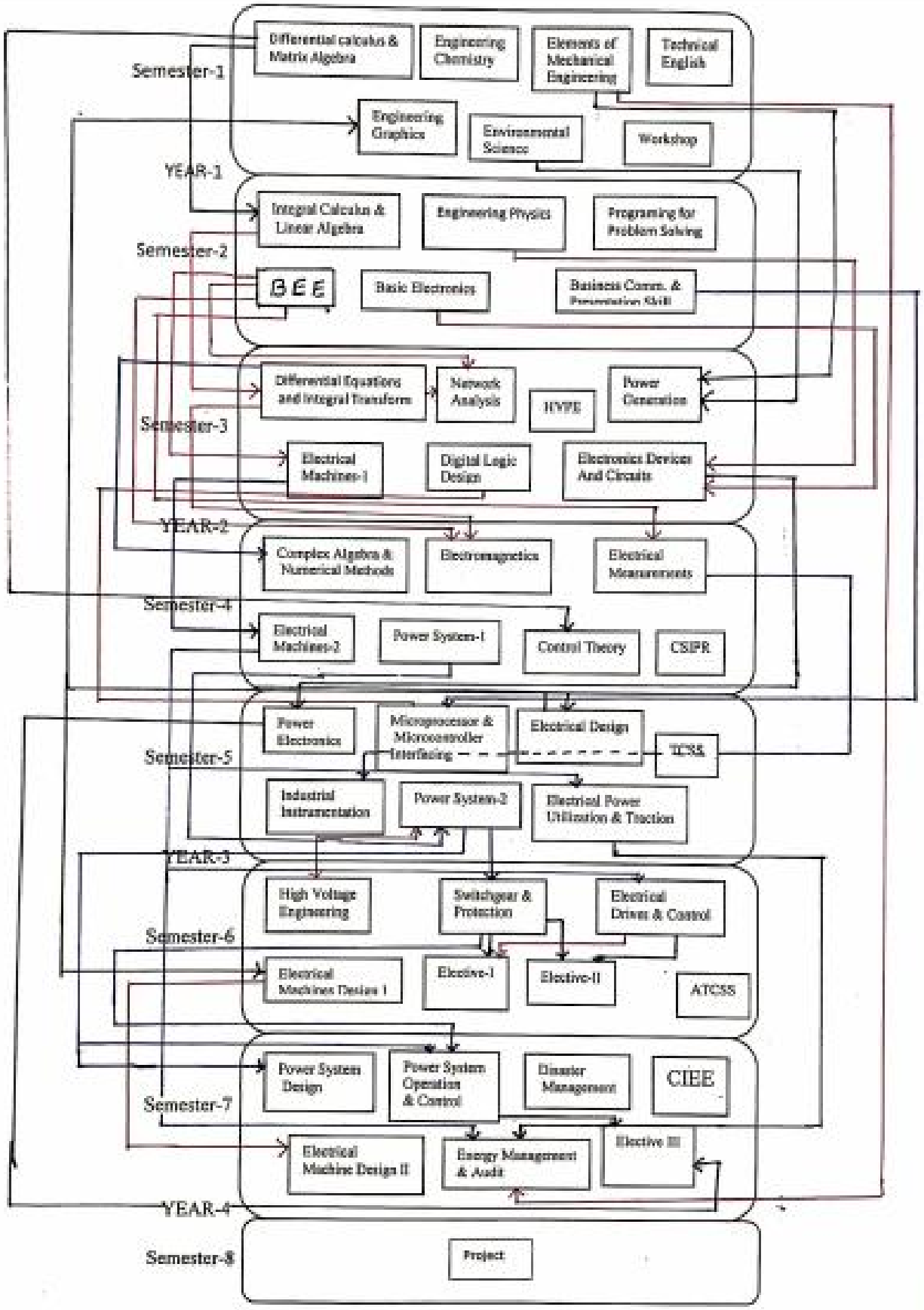
Course schedule(subject to change)

(Mention quiz, assignment submission, breaks etc as well in the table under the Teaching Learning Activity Column)

	Week #	Topic & contents	CO Addressed	Teaching Learning Activity (TLA)
	Weeks 1	Solid State Power Devices Power Semiconductor Devices Construction and Characteristics of Power diodes, Power Transistors, Power MOSFET, Insulated Gate Bipolar transistors (IGBTs) Introduction to Thyristor family: SCR, DIACs, TRIACs, Light Activated SCRs (LASCRs), Reverse Conducting Thyristor , (RCT)	1	BB, PPT
	Weeks 2	Asymmetrical SCR (ASCR), Gate turn-off Thyristors (GTOs), Integrated Gate- Commutated Thyristors (IGCTs), MOS controlled Thyristors (MCTs) Power Integrated circuits (PICs), Intelligent Modules. Gate Drive/Triggering circuits. di/dt and dv/dt protection, Design of Snubber Circuit.	1	BB, PPT
	Week 3	Phase Controlled (AC to DC) Converters: Review of half-wave and full-wave diode rectifier (with RL load); Principle of phase controlled converter operation; Operation of 1-phase half wave converter with R, RL and RLE load; Significance of freewheeling diode	*2,3*	BB, PPT
	Week 4	1- phase full wave converter: Center-tapped and Bridge Configuration;	2,3	BB, PPT

		Operation and analysis with R,RL, RLE load; Analysis; Gating Requirements; Operation and analysis of 1-phase Semi-converter/ Half controlled converter		
	Week 5	Asymmetric and Symmetric Configurations; 3-phase converters: Operation of half wave converter; Full wave fully controlled converters: Semi-controlled converter; Dual Converter: Principle and operation; 1-phase and 3-phase configurations	2,3	BB
	Week 6	Power factor improvement techniques, Applications of AC-DC converters	2,3	BB, PPT
	Week 7	DC to AC converters: Performance parameters of Inverters; Classification of Inverters: Voltage source inverters	3,4	BB, PPT
	Week 8	Current source inverters; Single phase inverters: series, parallel and bridge type (Half wave and Full wave) inverters; Forced Commutated, Line commutated and Self-Controlled	3,4	BB
	Week 9	Switches based Inverters; Three phase bridge inverters: 180-degree conduction, 120-degree conduction and their comparison	3,4	BB
	Week 10	PWM Inverters: Principle of PWM control, PWM techniques classifications, Comparison of Voltage and Current source Inverters.	5	BB, PPT

	Week 11	AC Voltage Controllers Concept of On-Off or integral cycle control and Phase control;	6	BB
	Week 12	Various single-phase full wave ac-ac controllers with R, L and RL load; Analysis for phase control and integral cycle control; Gating requirements; Sequence Control of AC regulators.	6	BB, PPT
	Week 13	DC to DC Converters The chopper, Basic principle of DC chopper, Classification of DC choppers, Control strategies Basic DC-DC converter (switch regulator) topologies:	6	BB, PPT
	Week 14	Principle, operation and analysis for Step-down (Buck), Step-up (Boost), Step up/down (Buck-Boost)	6	BB, PPT
	Week 15	Continuous conduction and Discontinuous conduction operation, Application of DC to DC converters.	6	BB, PPT



Elective-I: Advanced Control Theory, Industrial Automation, Soft Computing
Elective-II: Electrical Power Quality, EHV AC & DC, Special Machines, MOOC
Elective-III: FACTS, Advanced Power Electronics, Power System Planning, MOOC

Subject: Power Electronics								
Program: B.Tech. Electrical Engineering				**Subject Code: EL0526**			**Semester: V**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	0	2	4	60	60	40	40	200

Perquisites:

1) Basic Electronics
2) Mathematical Equations.

Course Objective:

1) To understand the characteristics and principle of operation of modern power semi-conductor devices.
2) To comprehend the concepts of different power converters and their applications
3) To analyze and design switched mode regulators for various industrial applications.

Course Outcome:

After completion of this course, expected outcome from the students,

1) Relate basic semiconductor physics to properties of real devices, and combine circuit mathematics and characteristics of linear and non-linear devices to formulate and analyse system designs.
2) The static and dynamic characteristics of fundamental power semiconductor devices.
3) Learn the basic concepts of operation of different types of converters in steady state in continuous and discontinuous modes and be able to analyze basic converter topologies.
4) Apply skills in engineering estimation to analyze real-world situations, identify the important features and develop a valid approach to the solution.
5) Simulate simple power electronic circuits using simulation packages like Spice or MATLAB/Simulink.
6) Conduct experiments with converters and compare the results with theoretical concepts and simulations.

SYLLABUS

UNIT-I **[12]**

Solid State Power Devices

Power Semiconductor Devices Construction and Characteristics of Power diodes, Power Transistors, Power MOSFET, Insulated Gate Bipolar transistors (IGBTs) Introduction to Thyristor family : SCR, DIACs, TRIACs, Light Activated SCRs (LASCRs), Reverse Conducting Thyristor , (RCT), Asymmetrical SCR (ASCR), Gate turn-off Thyristors (GTOs), Integrated Gate- Commutated Thyristors (IGCTs), MOS controlled Thyristors (MCTs) Power Integrated circuits (PICs), Intelligent Modules. Gate Drive/Triggering circuits. di/dt and dv/dt protection, Design of Snubber Circuit.

UNIT-II **[10]**

Phase Controlled (AC to DC) Converters:

Review of half-wave and full-wave diode rectifier (with RL load); Principle of phase controlled converter operation; Operation of 1-phase half wave converter with R, RL and RLE load; Significance of freewheeling diode ; 1- phase full wave converter : Center-tapped and Bridge Configuration; Operation and analysis with R,RL, RLE load; Analysis; Gating Requirements; Operation and analysis of 1-phase Semi-converter/ Half controlled converter: Asymmetric and Symmetric Configurations; 3-phase converters : Operation of half wave converter; Full wave fully controlled converters: Semi-controlled converter; Dual Converter: Principle and operation; 1-phase and 3-phase configurations, Power factor improvement techniques, Applications of AC-DC converters

UNIT-III **[10]**

DC to AC converters:

Performance parameters of Inverters; Classification of Inverters: Voltage source inverters and Current source inverters; Single phase inverters: series, parallel and bridge type (Half wave and Full wave) inverters; Forced Commutated, Line commutated and Self-Controlled Switches based Inverters; Three phase bridge inverters: 180 degree conduction, 120 degree conduction and their comparison PWM Inverters: Principle of PWM control, PWM techniques classifications, Comparison of Voltage and Current source Inverters.

UNIT-IV **[13]**

AC Voltage Controllers

Concept of On-Off or integral cycle control and Phase control; Various single phase full wave ac-ac controllers with R, L and RL load; Analysis for phase control and integral cycle control; Gating requirements; Sequence Control of AC regulators.

DC to DC Converters

The chopper, Basic principle of DC chopper, Classification of DC choppers, Control strategies Basic DC-DC converter (switch regulator) topologies : Principle, operation and analysis for Step-down (Buck), Step-up (Boost), Step up/down (Buck-Boost), Continuous conduction and Discontinuous conduction operation, Application of DC to DC converters. E-mobility : Power Electronic

converters & their control for Electric vehicles, Control of electric motors for traction.

Text Books

1. Bimbhra, P. S., "Power electronics", Khanna Publishers, New Delhi, 2001
2. Rashid, M. H., " Power Electronics Circuits, Devices, and Applications, Prentice-Hall of India Pvt. Ltd., New Delhi, 2nd edition, 1999.
3. Singh, M. D., Khanchandani, K. B "Power electronics", Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2001.

Reference Books

1. Ned Mohan, Tore M. Undeland and William P. Robbins, “Power Electronics Converters, Applications, and Design”, John Willey & Sons, Inc., 2ndEdition, 1995.
2. Agrawal, J. P., "Power electronic systems: Theory and design" Addison Wesley Longman (Singapore) Pte. Ltd. New Delhi, 2001
3. Boylestad R. and Nashelsky L., “Electronic Devices and Circuit Theory”, 9th Ed., Prentice Hall of India Private Limited. 2008
4. Gayakward R. A., “ OP-AMPs and Linear Integrated Circuit Technology ” , 4th Ed., Pearson Education. 2008
5. Dubey G. K., Doradla S. R., Joshi A. and Sinha R. M. K., Thyristorised Power Controllers”, New Age International Private Limited. 2008

Web Resource

nptel.ac.in/downloads/108105066/

Name of Institute: Indus Institute of Technology & Engineering
Name of Faculty: Zalak Trivedi

Course code: CE0525/CS0525/IT0525
Course name: Programming for Scientific Computing (Python)

Pre-requisites: -
Knowledge of Object Oriented language will be useful.

Credit points: 4
Offered Semester: V

Course coordinator
Full name: Zalak Trivedi
Department with sitting location: CE dept, 4th floor Bhanwar Building.
Telephone: -
Email: zalaktrivedi.ce@indusuni.ac.in
Consultation times:
Monday 11.55am to 2:00pm
Friday 01.30pm to 2.30pm

Course lecturer
Full name: Zalak Trivedi
Department with sitting location: CE dept, 4th floor Bhanwar Building.
Telephone:
Email: zalaktrivedi.ce@indusuni.ac.in
Consultation times:
Monday 11.55am to 2:00pm
Friday 01.30pm to 2.30pm

Students will be contacted throughout the session via mail with important information relating to this course.

Course Objectives:

1. Importance of Python as scientific computing tool which directly leads to employability .
2. To learn how to design and develop Python applications.
3. Skill development to apply mutable and immutable types.
4. To learn how to design object-oriented concepts in python.
5. Development of GUI based applications for entrepreneurship.
6. To learn how to build and package Python modules for re usability.

Course Outcomes (CO)

At the end of this subject, students should be able to:
1. Work with the Python standard libraries

2. Implement mutability for various elements of python
3. Develop GUI based projects
4. Design Networking configuration for chatting applications
5. Implement Scientific Computing
6. Solve Real world problems using python programming

Course Outline

UNIT-I	[12 hours]

Basic elements of python, Branching, looping, Strings and Input, Iteration, Functions, Recursion, Global variables, Modules, Files, Structured Objects, Mutability: Strings, Tuples, Lists, Sets, Dictionaries, ,Functions as Objects, Mutability and Higher-Order Functions.

UNIT-II	[12 hours]

Object-Oriented Programming, Abstract Data Types and Classes, Encapsulation and Information Hiding, Simple Algorithms and Data structures, Regular Expressions – REs ,Networking, Multithreading in Python.

UNIT-III	[12 hours]

Array computing and curve plotting, vectors and higher-dimensional arrays, matrices, numPy, sciPy and Matplotlib, Plotting using PyLab, Chat Application, Graphics and GUI Programming – Drawing using Turtle, Tkinter.

UNIT-IV	[12 hours]

Python Pandas - Data alignment, aggregation, summarization, computation and analysis with Pandas. Scientific computation using python - Statistical data analysis, image processing, Basics of Web development(Introduction to frameworks flask, tensor flow).

Method of delivery

Chalk and Board, PowerPoint presentation

Study time

3 hrs theory, 2 Hrs practical

CO-PO Mapping (PO: Program Outcomes)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	-	-
CO2	3	1	1	-	-	-	-	-	-	-	-	-

CO3	3	3	2	-	-	-	-	-	-	-	-	-
CO4	2	1	-	-	-	-	-	-	-	-	-	-
CO5	3	3	2	-	-	-	-	-	-	-	-	-
CO6	3	3	2	-	-	-	-	-	-	-	-	-

Blooms Taxonomy and Knowledge retention (For reference)

(Blooms taxonomy has been given for reference)

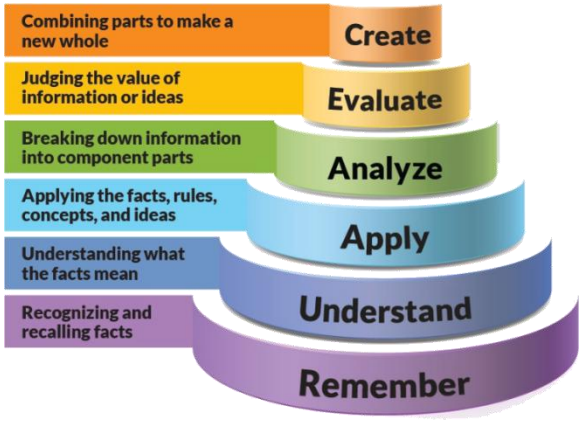


Figure 1: Blooms Taxonomy

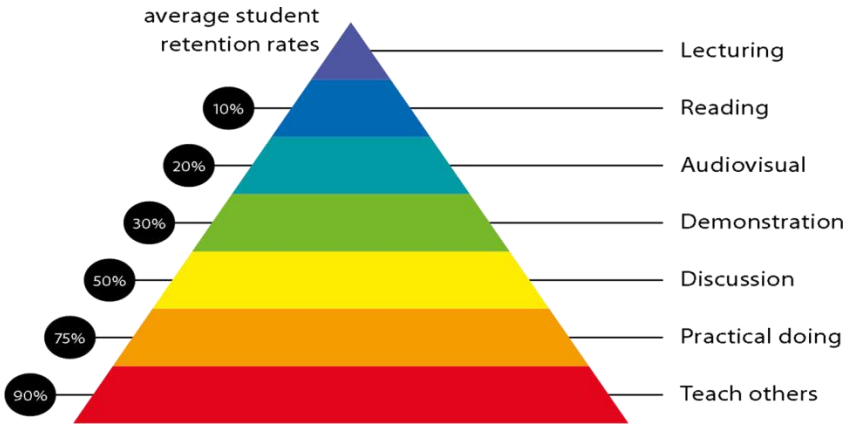


Figure 2: Knowledge retention

Graduate Qualities and Capabilities covered

(Qualities graduates harness crediting this Course)

General Graduate Qualities	Specific Department of _____Graduate Capabilities
Informed Have a sound knowledge of an area of study or profession and understand its current issues, locally and internationally. Know how to apply this knowledge. Understand how an area of study has developed and how it relates to other areas.	**1 Professional knowledge, grounding & awareness**

Independent learners Engage with new ideas and ways of thinking and critically analyze issues. Seek to extend knowledge through ongoing research, enquiry and reflection. Find and evaluate information, using a variety of sources and technologies. Acknowledge the work and ideas of others.	**2 Information literacy, gathering & processing**
Problem solvers Take on challenges and opportunities. Apply creative, logical and critical thinking skills to respond effectively. Make and implement decisions. Be flexible, thorough, innovative and aim for high standards.	**4 Problem solving skills**
Effective communicators Articulate ideas and convey them effectively using a range of media. Work collaboratively and engage with people in different settings. Recognize how culture can shape communication.	**5 Written communication** **6 Oral communication** **7 Teamwork**
Responsible Understand how decisions can affect others and make ethically informed choices. Appreciate and respect diversity. Act with integrity as part of local, national, global and professional communities.	**10 Sustainability, societal & environmental impact**

Practical work:

1	**Develop programs to understand the control structures of python** Write a Python program to print the calendar of a given month and year. Write a Python program to calculate number of days between two dates. Write a Python program to check whether a specified value is contained in a group of values. *Test Data* : 3 -> [1, 5, 8, 3] : True -1 -> [1, 5, 8, 3] : False Write a Python program to get OS name, platform and release information.	Basic knowledge of python Programming
2	**Develop programs to learn different types of structures (list, dictionary, tuples) in python** Write a Python program which accepts a sequence of comma-separated numbers from user and generate a list and a tuple with those numbers. Write a Python program to display the first and	Basic knowledge of strings and operation on strings in python.

	last colors from the following list.[orange, purple, red,yellow,blue] Write a Python program to concatenate all elements in a list into a string and return it. Write a Python program to print out a set containing all the colors from color_list_1 which are not present in color_list_2. *Test Data* : color_list_1 = set(["White", "Black", "Red"]) color_list_2 = set(["Red", "Green"]) *Expected Output* : {'Black', 'White'}	
3	Write a Python script to print a dictionary where the keys are numbers between 1 and 15 (both included) and the values are square of keys. Sample Dictionary {1: 1, 2: 4, 3: 9, 4: 16, 5: 25, 6: 36, 7: 49, 8: 64, 9: 81, 10: 100, 11: 121, 12: 144, 13: 169, 14: 196, 15: 225}	Basic knowledge of Dictionaries
4	Develop programs to learn concept of functions scoping, recursion and list mutability	Basic knowledge function
5	Develop programs to understand working of exception handling and assertions	Basic knowledge of exception and assertions
6	Develop programs for data structure algorithms using python – searching, sorting and hash tables	Basic knowledge of data structure
7	Develop programs to learn regular expressions using python	Basic principle of Regular Expressions
8	Develop chat room application using multithreading.	Basic knowledge of multithreading
9	Implement classical ciphers using python	Basic knowledge of encryption decryption.
10	Demonstration of Database Connectivity	Knowledge of database connectivity and basic framework
11	Practicals based on Numpy statistical analysis.	Knowledge of Numpy
12	Practicals based on Pandas.	Knowledge of Pandas

Lecture/Tutorial times

(Give lecture times in the format below)

Lecture	**Monday**	**11.10 AM to 12.10 PM**
Lecture	**Tuesday**	**9.00 AM to 10.00 AM**
Lecture	**Wednesday**	**11.10 AM to 12.10 PM**
Practical (A1)	**Monday**	**2.00 PM to 4.10 PM**
Practical (A2)	**Tuesday**	**2.00 PM to 4.10 PM**

Attendance Requirements

The University norms states that it is the responsibility of students to attend all lectures, tutorials, seminars and practical work as stipulated in the course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for semester examinations.

Reference Books:

1. John V Guttag. "Introduction to Computation and Programming Using Python", Prentice Hall of India
2. R. Nageswara Rao, "Core Python Programming", dreamtech
3. Wesley J. Chun. "Core Python Programming - Second Edition", Prentice Hall
4. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, "Data Structures and Algorithms in Pyhon", Wiley
5. Kenneth A. Lambert, "Fundamentals of Python – First Programs", CENGAGE Publication
6. Luke Sneeringer, "Professional Python", Wrox
7. "Hacking Secret Ciphers with Python", Al Sweigart, URL-https://inventwithpython.com/hacking/chapters

Online Courses:

https://www.youtube.com/watch?v=N4mEzFDjqtA
https://www.youtube.com/watch?v=hnxIRVZ0EyU
https://www.youtube.com/watch?v=tKTZoB2Vjuk

ASSESSMENT GUIDELINES

Your final course mark will be calculated from the following:

CIE - Theory (60 Marks) **Class Regularity– 05 Marks** **Class Test- 40 Marks** **Quiz/Assignment:15 Marks**	**CIE - Practical (60 Marks)** **Class Regularity – 05 Marks** **Lab Performance/Submission-20 Marks** **Minor Project: 35 Marks**
ESE-Theory- 40 Marks	**ESE-Practical-40 Marks**
Total: 200 Marks	**Total: 200 Marks**

SUPPLEMENTARY ASSESSMENT

Students who receive an overall mark less than 40% in internal component or less than 40% in the end semester will be considered for supplementary assessment in the respective components (i.e internal component or end semester) of semester concerned. Students must make themselves available during the supplementary examination period to take up the respective components (internal component or end semester) and need to obtain the required minimum 40% marks to clear the concerned components.

Practical Work Report/Laboratory Report:

A report on the practical work is due the subsequent week after completion of the class by each group.

Late Work

Late assignments will not be accepted without supporting documentation. Late submission of the reports will result in a deduction of -% of the maximum mark per calendar day

Format

All assignments must be presented in a neat, legible format with all information sources correctly referenced. **Assignment material handed in throughout the session that is not neat and legible will not be marked and will be returned to the student.**

Retention of Written Work

Written assessment work will be retained by the Course coordinator/lecturer for two weeks after marking to be collected by the students.

University and Faculty Policies

Students should make themselves aware of the University and/or Faculty Policies regarding plagiarism, special consideration, supplementary examinations and other educational issues and student matters.

Plagiarism - Plagiarism is not acceptable and may result in the imposition of severe penalties. Plagiarism is the use of another person's work, or idea, as if it is his or her own - if you have any doubts at all on what constitutes plagiarism, please consult your Course coordinator or lecturer. Plagiarism will be penalized severely.

Do not copy the work of other students.
Do not share your work with other students (except where required for a group activity or assessment.

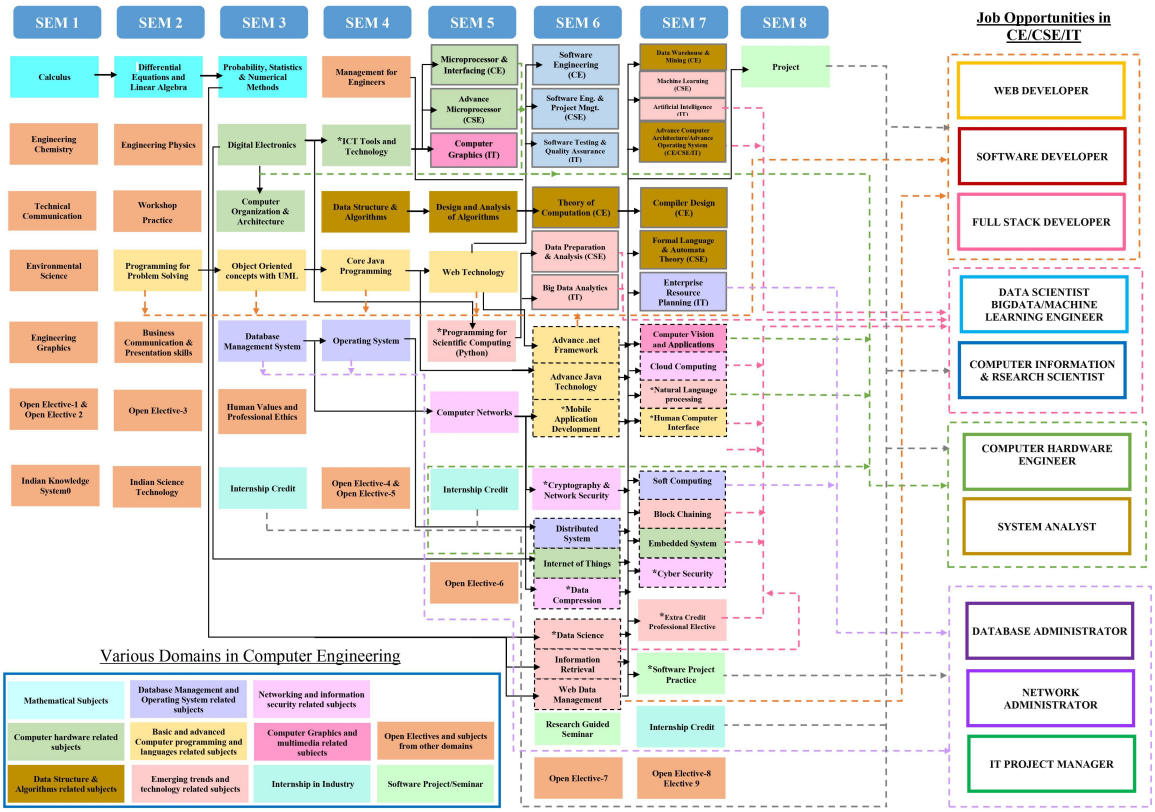
Course schedule (subject to change)

(Mention quiz, assignment submission, breaks etc as well in the table under the Teaching Learning Activity Column)

	Week #	Topic & contents	CO Addressed	Teaching Learning Activity (TLA)
	Week 1	Basic elements of python, Branching, looping, Strings and Input, Iteration	I	Chalk & Board, Discussion
	Week 2	Functions, Recursion, Global variables	I	Presentation, Chalk & Board
	Week 3	Modules, Files	I	Presentation, Chalk & Board
	Week 4	Structured Objects, Mutability: Strings, Tuples, Lists, Sets, Dictionaries	II	Presentation, Chalk & Board
	Week 5	Functions as Objects, Mutability and Higher-Order Functions	II	Presentation, Chalk & Board
	Week 6	Object-Oriented Programming		Model presentation

	Week 7	Abstract Data Types and Classes, Encapsulation and Information Hiding	II	Presentation, Chalk & Board, Demonstration
	Week 8	Simple Algorithms and Data structures	II	Presentation, Chalk & Board, Demonstration
	Week 9	Regular Expressions – REs ,Networking, Multithreading in Python	*II*	Presentation, Chalk & Board
	Week 10	Array computing and curve plotting	*II*	Presentation, Chalk & Board
	Week 11	Vectors and higher-dimensional arrays, matrices, numPy, sciPy and Matplotlib, Plotting using PyLab	*III*	Presentation, Chalk & Board
	Week 12	Chat Application, Graphics and GUI Programming – Drawing using Turtle, Tkinter	III	Presentation, Chalk & Board
	Week 13	Python Pandas - Data alignment, aggregation, summarization, computation and analysis with Pandas	IV	Presentation, Chalk & Board
	Week 14	Scientific computation using python - Statistical data analysis, image processing	VI	Presentation, Chalk & Board
	Week 15	Basics of Web development(Introduction to frameworks flask, tensor flow)	VI	Presentation, Chalk & Board

COMPUTER ENGINEERING DEPARTMENT COURSE DEPENDANCY CHART



Name of Institute: Institute of Technology & Engineering

Name of Faculty:Vineeta S. Chauhan

Course code: EL0516

Course name: Power System-II

Pre-requisites: Power System –I, Fundamentals of Power System

Credit points: 04

Offered Semester: V

Course Coordinator

Full Name: Vineeta S. Chauhan

Department with sitting location: Electrical Engineering Department,

2nd floor , EEE LAB-1, Bhanwar Building.

Telephone: 9638251076

Email: vineetachauhan.el@ indusuni.ac.in

Consultation times: 4:15 – 4:50 p.m.

Course Lecturer

Full Name: Vineeta S. Chauhan

Department with sitting location: Electrical Engineering Department,

2nd floor , EEE LAB-1, Bhanwar Building.

Telephone: 9638251076

Email: vineetachauhan.el@ indusuni.ac.in

Consultation times: 4:15 – 4:50 p.m.

Students will be contacted throughout the Session via Mail with important information relating to this Course.

Course Objectives

By participating in and understanding all facets of this Course a student will:

1) To prepare mathematical model of the transmission system.
2) To analyze symmetrical components and their mathematical model
3) To study short circuit symmetrical and unsymmetrical condition.
4) To study Asymmetrical Fault Analysis using different mathematical methods
5) To analyze transients in power system.

Course Outcomes (CO)

CO1: Create computational models for analysis of power systems and able to understand per unit system. [BT-6]
CO 2: Solve load flow computations and analyze the load flow results. [BT-3]
CO3: Analyze power system network under Symmetrical and Unsymmetrical conditions. [BT-4]
CO4: Determine positive Sequence, Negative Sequence and Zero Sequence and fault analysis.[BT-3]
CO5: Explain the concept of Power System Transients and protection against It. [BT-2]
CO6: Determine the electrical parameters and characteristics of transmission lines. [BT-3]

Course Outline

This course mainly deals with different types faults in power system. This subjects deals with detailed analysis of the faults and their mathematical model analysis. The power system transients are also covered.

Method of delivery

Face to face lectures

Study time

3 Hour Lecture and 2 Hour Practical Laboratory per week

CO-PO Mapping (PO: Program Outcomes)

Mapping CO's with PO's

	PO1	PO2	PO3	PO 4	PO 5	PO6	PO7	PO8	PO 9	PO10	PO11	PO1 2
CO1	3	-	3	1	-	-	-	-	-	-	-	-
CO2	3	2	3	2	-	-	-	-	-	-	-	-
CO3	3	2	3	2	-	-	-	-	-	-	-	-
CO4	3	2	3	3	-	-	-	-	-	-	-	-
CO5	3	2	3	2	-	-	-	-	-	-	-	-
CO6	3	2	3	2	-	-	-	-	-	-	-	-

1-Lightly Mapped 2- Moderately Mapped 3- Highly Mapped

Blooms Taxonomyand Knowledge retention(For reference)

(Blooms taxonomy has been given for reference)

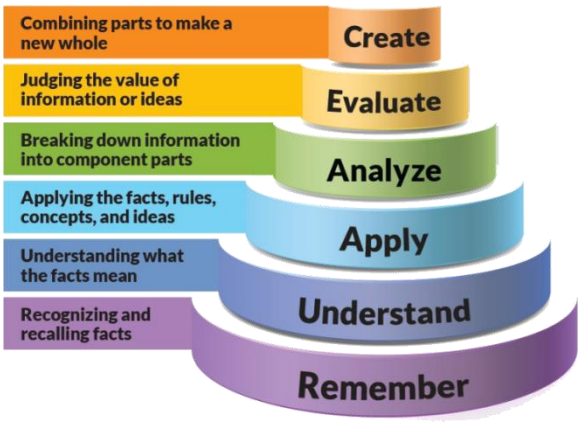


Figure 1: Blooms Taxonomy

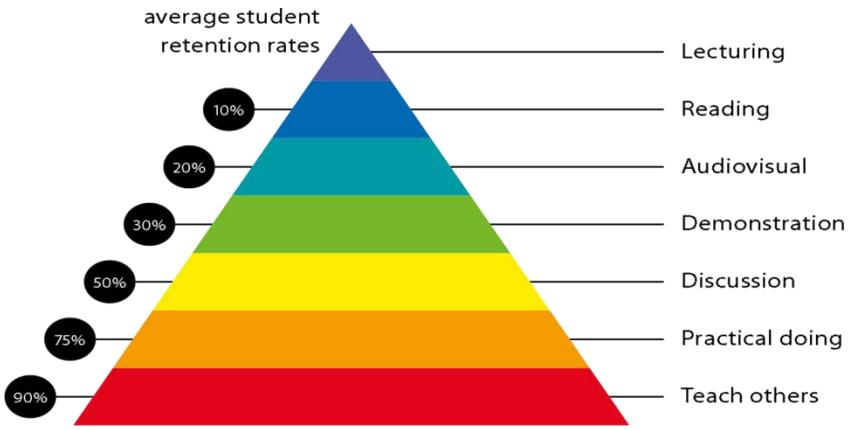


Figure 2: Knowledge retention

Graduate Qualities and Capabilities covered

(Qualities graduates harness crediting this Course)

General Graduate Qualities	Specific Department of _____Graduate Capabilities
Informed Have a sound knowledge of an area of study or profession and understand its current issues, locally and internationally. Know how to apply	**1 Professional knowledge, grounding & awareness**

this knowledge. Understand how an area of study has developed and how it relates to other areas.	
Independent learners Engage with new ideas and ways of thinking and critically analyze issues. Seek to extend knowledge through ongoing research, enquiry and reflection. Find and evaluate information, using a variety of sources and technologies. Acknowledge the work and ideas of others.	**2 Information literacy, gathering & processing**
Problem solvers Take on challenges and opportunities. Apply creative, logical and critical thinking skills to respond effectively. Make and implement decisions. Be flexible, thorough, innovative and aim for high standards.	**4 Problem solving skills**
Effective communicators Articulate ideas and convey them effectively using a range of media. Work collaboratively and engage with people in different settings. Recognize how culture can shape communication.	**5 Written communication** **6 Oral communication** **7 Teamwork**
Responsible Understand how decisions can affect others and make ethically informed choices. Appreciate and respect diversity. Act with integrity as part of local, national, global and professional communities.	**10 Sustainability, societal & environmental impact**

Practical work:

(Mention what practical work this Course involves)

Lecture/tutorial times

Attendance Requirements

The University norms states that it is the responsibility of students to attend all lectures, tutorials, seminars and practical work as stipulated in the Course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for mid and end semester examinations.

Details of referencing system to be used in written work

Text books

1.G.W. Stagg ; A. H. EI-Abaid, “Computer methods in Power System Analysis”, McGraw Hill, New York.

2. W. D. Stevenson , “Element of Power System Analysis”, Mc Graw Hill, 1982.

3. Nagrath & kothari, “ Power System Engineering”, TMH publishing Company Ltd.

Reference Books

1.C.L.Wadhwa, “Electric Power System”, New Age International Ltd.

2. C. S. Indulkar and D P Kothari, “Power System Transients, A Statistical Approach”, Prentice Hall of India Pvt Ltd., New Delhi.

3. N. G. Hingorani, J Gyugi, “Understanding FACTS”, IEEE Press.

4. K. Bhattacharya, MHT Bollern and J. C. Doolder, “Operation of Restructured Power Systems”, Kluwer Academic Publishers, USA, 2001.

Additional Materials

1. nptel.ac.in/downloads/108101040/

2. https://www.smartzworld.com/notes/power-system-ii-ps-ii/

ASSESSMENT GUIDELINES

Your final course mark will be calculated from the following:

Theory

CIE 60 marks (40 marks mid semester examination + 20 marks internal evaluation)

Components of internal evaluation
05 marks as attendance bonus for all students having attendance > 80%
05 marks for presentation
10 marks for assignment or case studies

Laboratory

File Work (10 marks)
Lab Participation (20 marks)
Project / Presentation (20 marks)
Viva – Voice (10 marks)

End Term Examination: 40 marks

SUPPLEMENTARY ASSESSMENT

Students who receive an overall mark less than 40% in internal component or less than 40% in the end semester will be considered for supplementary assessment in the respective components (i.e internal component or end semester) of semester concerned. Students must make themselves available during the supplementary examination period to take up the respective components (internal component or end semester) and need to obtain the required minimum 40% marks to clear the concerned components

Practical Work Report/Laboratory Report:

A report on the practical work is due the subsequent week after completion of the class by each group.

Late Work

Late assignments will not be accepted without supporting documentation. Late submission of the reports will result in a deduction of -% of the maximum mark per calendar day

Format

All assignments must be presented in a neat, legible format with all information sources correctly referenced. **Assignment material handed in throughout the session that is not neat and legible will not be marked and will be returned to the student.**

Retention of Written Work

Written assessment work will be retained by the Course coordinator/lecturer for two weeks after marking to be collected by the students.

University and Faculty Policies

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Do not copy the work of other students.
Do not share your work with other students (except where required for a group activity or assessment)

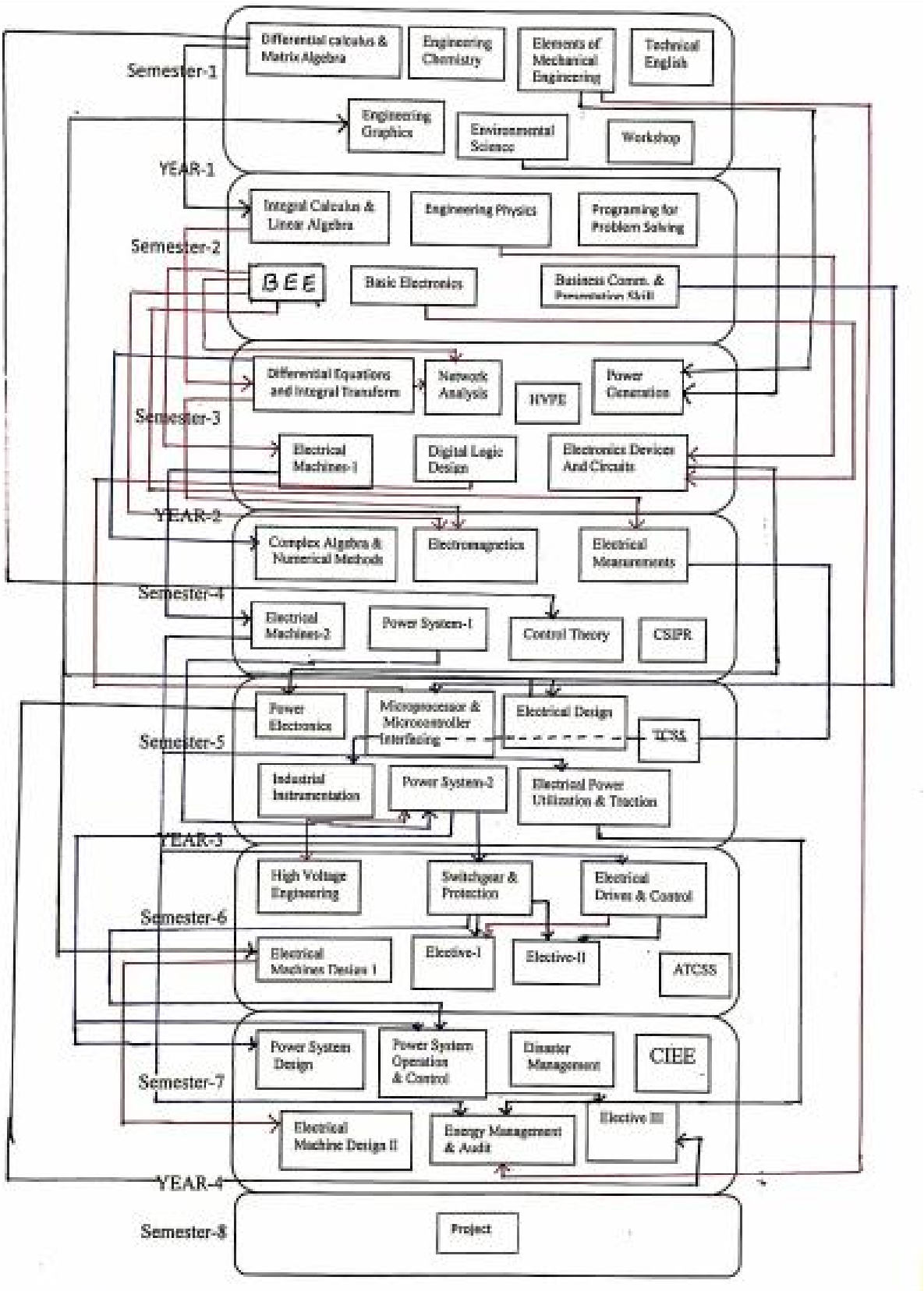
.Course schedule(subject to change)

(Mention quiz, assignment submission, breaks etc as well in the table under the Teaching Learning Activity Column)

	Week #	Topic & contents	CO Addressed	Teaching Learning Activity (TLA)
	Weeks 1	Representation of Power System Components Introduction, single phase solution of balanced three phase networks, the one line diagram and the impedance or reactance diagram,	CO1	Chalk & Talk
	Weeks 2	Per-unit (pu) system, complex power, synchronous machine, representation of loads. Characteristics and performance of power transmission lines	CO1	Chalk & Talk
	Week 3	Short and medium transmission lines, Line performance, effect of capacitance, charging currents, short and medium lines, calculation by nominal-T, nominal-π and end- condenser method, regulation and efficiency, Concept of ABCD constants, the long transmission line-rigorous solution	*CO1, CO2*	Chalk & Talk
	Week 4	Evaluation of ABCD constants, interpretation of long line equation, surge impedance and surge impedance loading, the equivalent circuit of a long transmission line, power flow through a transmission line, circle diagrams, Ferranti effect.	*CO1, CO2*	Chalk & Talk
	Week 5	Review of Symmetrical Components and Its Application to Power System Symmetrical component transformation, phase shift in star-delta transformers, sequence impedance of transmission	*CO1, CO2, CO3*	Chalk & Talk

		lines, sequence impedance and sequence network of power system,		
	Week 6	Sequence impedance and network of synchronous machine, sequence impedance of transmission lines, sequence impedance and networks of transformers, construction of sequence networks of power systems	*CO5*	Chalk & Talk
	Week 7	Symmetrical Fault Analysis- Introduction, transient on a transmission line, short circuit of a synchronous machine on no load, short circuit of a loaded synchronous machine, balanced three phase fault, short circuit capacity	CO5	Chalk & Talk
	Week 8	Fault analysis using bus impedance matrix, selection of protective equipments	CO5	Chalk & Talk
	Week 9	Unsymmetrical Fault Analysis - Symmetrical component analysis of unsymmetrical faults, single line to ground (LG) fault, line-to line (LL) fault,	*C02*	Chalk & Talk
	Week 10	Double line to ground (LLG) fault, open conductor faults	*C02*	Chalk & Talk
	Week 11	Bus impedance matrix method for analysis of unsymmetrical faults	CO4	Chalk & Talk
	Week 12	Power System Transients -Types of system transients, factors affecting transients	CO4	Chalk & Talk
	Week 13	Reflection and refraction of traveling Waves at different line termination, surge impedance, transient over voltages due to lightning	CO4	Chalk & Talk
	Week 14	Theory of ground wires, direct stroke to a tower, capacitive switching, kilometric fault,	CO4, CO6	Chalk & Talk

	Week 15	Ferro-resonance, protection of power systems against transients and insulation coordination	CO4,CO6	Chalk & Talk



Elective-I: Advanced Control Theory, Industrial Automation, Soft Computing
Elective-II: Electrical Power Quality, EHV AC & DC, Special Machines, MOOC
Elective-III: FACTS, Advanced Power Electronics, Power System Planning, MOOC

Subject: Power System-II								
Program: B.Tech. Electrical Engineering			**Subject Code: EL0516**			**Semester: V**		
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	0	2	4	60	60	40	40	200

Perquisites:

i) Basics Electrical Engineering

ii) Fundamentals of optimization techniques.

Course Objective

i) Understand the basic concept of Per Unit System.

ii) Understand the basic concept of load flow analysis

iii) Understand the Concept of designing transmission line parameters

Course Outcome:

i) To study short circuit symmetrical and unsymmetrical condition.

ii) An ability to calculate power flow Analysis using different mathematical methods.

iii) Illustrate the concept of steady state and transient stability

iv) An ability to Analysis of unsymmetrical fault

v) An ability to Analysis of symmetrical fault

vi) An ability to Analysis of power system using symmetrical components transformation.

SYLLABUS

UNIT-I **[10]**

Representation of Power System Components

Introduction, single phase solution of balanced three phase networks, the one line diagram and the impedance or reactance diagram, per-unit (pu) system, complex power, synchronous machine, representation of loads.

Characteristics and Performance of Power Transmission Lines

Short and medium transmission lines, Line performance, effect of capacitance, charging currents, short and medium lines, calculation by nominal-T, nominal- π and end- condenser method, regulation and efficiency, Concept of ABCD constants, the long transmission line-rigorous solution, evaluationof ABCD constants, interpretation of long line equation, surge impedance and surge

impedance loading, the equivalent circuit of a long transmission line, power flow through a transmission line, circle diagrams, Ferranti effect.

UNIT-II **[13]**

Review of Symmetrical Components and Its Application to Power System

Symmetrical component transformation, phase shift in star-delta transformers, sequence impedance of transmission lines, sequence impedance and sequence network of power system, sequence impedance and network of synchronous machine, sequence impedance of transmission lines, sequence impedance and networks of transformers, construction of sequence networks of power systems.

Symmetrical Fault Analysis

Introduction, transient on a transmission line, short circuit of a synchronous machine on no load, short circuit of a loaded synchronous machine, balanced three phase fault, short circuit capacity, fault analysis using bus impedance matrix, selection of protective equipments.

UNIT-III **[13]**

Unsymmetrical Fault Analysis

Symmetrical component analysis of unsymmetrical faults, single line to ground (LG) fault, line to line (LL) fault, double line to ground (LLG) fault, open conductor faults, bus impedance matrix method for analysis of unsymmetrical faults.

UNIT-IV **[10]**

Power System Transients

Types of system transients, factors affecting transients, reflection and refraction of traveling waves at different line termination, surge impedance, transient over voltages due to lightning, theory of ground wires, direct stroke to a tower, capacitive switching, kilometric fault, ferro- resonance, protection of power systems against transients and insulation coordination.

Text Books

1. G.W. Stagg & A. H. EI-Abaid, “Computer methods in Power System Analysis”, McGraw Hill, New York.
2. W. D. Stevenson , “Element of Power System Analysis”, Mc Graw Hill, 1982.
3. Nagrath & kothari, “ Power System Engineering”, TMH publishing Company Ltd.

Reference Book

1. C.L.Wadhwa, “Electric Power System”, New Age International Ltd.
2. C. S. Indulkar and D P Kothari, “Power System Transients, A Statistical Approach”, Prentice Hall of India Pvt Ltd., New Delhi.
3. N. G. Hingorani, J Gyugi, “Understanding FACTS”, IEEE Press.

4. K. Bhattacharya, MHT Bollern and J. C. Doolder, "Operation of Restructured Power Systems", Kluwer Academic Publishers, USA, 2001.

Web Resource

i) https://www.smartzworld.com/notes/power-system-ii-ps-ii/
ii) https://www.eee.hku.hk
iii) http://www.srmuniv.ac.in

MOOCS:

i) nptel.ac.in/downloads/108101040/
ii) www.edx.org

Name of Institute: Institute of Technology & Engineering

Name of Faculty: Prof. Rashmi Sharma

Course code: EL0520-Elective I

Course name: Renewable Energy Sources

Pre-requisites:

1. Knowledge of Conventional Sources of Energy
2. Knowledge of Basic Structure of Energy Flow in Power Network

Credit points: 04

Offered Semester: V

Course coordinator (weeks 01 - 15)

Full name: Prof. Rashmi Sharma

Department with siting location: 3rd floor, Bhawar Building

Telephone:3212

Email: rashmisharma.el@indusuni.ac.in

Consultation times: 9:00 a.m. to 5:00 p.m.

Course lecturer (weeks 01 - 15)

Full name: Prof. Rashmi Sharma

Department with siting location: 3rd floor, Bhawar Building

Telephone:3212

Email: rashmisharma.el@indusuni.ac.in

Consultation times: 9:00 a.m. to 5:00 p.m.

Students will be contacted throughout the session via mail with important information relating to this course.

Course Objectives

By participating in and understanding all facets of this course a student will:

1. To Study the Available Renewable Sources.
2. To Study the Energy Generation the Solar Cells and Plants.

3. To Study the concepts of wind power conversion
4. To study the energy conversion from ocean energy

Course Outcomes (CO)

CO 1: Identify the potential energy sources available in world
CO 2: Understand the concept of conversion of Geothermal energy
CO 3: Understand the concept of conversion of Solar energy
CO 4: Understand the concept of conversion of Wind energy
CO 5:Understand the concept of conversion of Ocean energy
CO 6: Understand the concept of conversion of Tidal energy

Course Outline

In this course different non-conventional sources of energy (renewable energy sources) have been discussed and have been analyzed in the scope of electrical engineering.

Method of delivery

Face to face lectures, Assignments, Presentations

Study time

3-hour lecture and 1-hour tutorial per week

CO-PO Mapping (PO: Program Outcomes)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	3	2	2	1	1	1					-	2
CO2	3	2	2	1	1	1					-	2
CO3	3	3	3	2	2	1					1	2
CO4	3	3	3	3	2	1					1	2
CO5	3	2	2	1	1	1					-	2
CO6	3	3	3	2	2	1					1	2

Blooms Taxonomy and Knowledge retention (For reference)

(Blooms taxonomy has been given for reference)

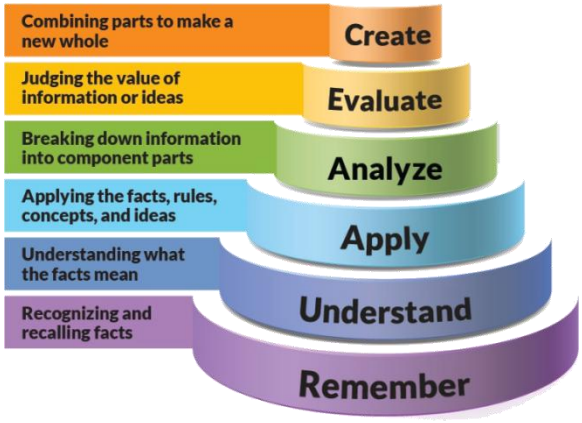


Figure 1: Blooms Taxonomy

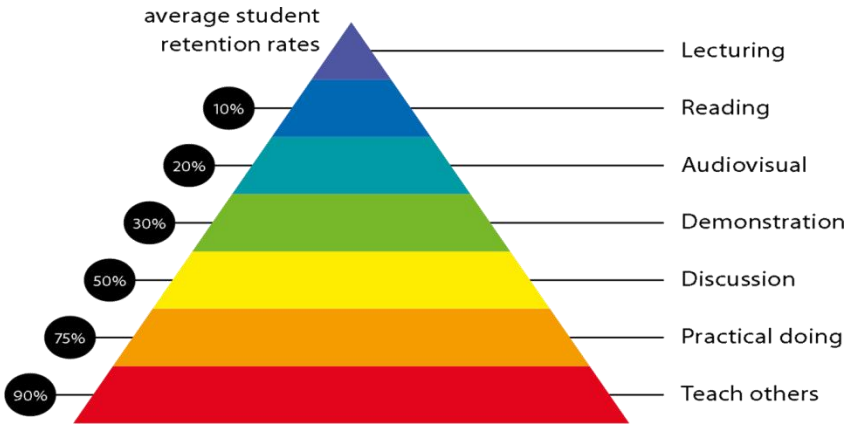


Figure 2: Knowledge retention

Graduate Qualities and Capabilities covered

(Qualities graduates harness crediting this Course)

General Graduate Qualities	Specific Department of _____Graduate Capabilities
Informed Have a sound knowledge of an area of study or profession and understand its current issues, locally and internationally. Know how to apply this knowledge. Understand how an area of study has developed and how it relates to other areas.	**1 Professional knowledge, grounding & awareness**

Independent learners Engage with new ideas and ways of thinking and critically analyze issues. Seek to extend knowledge through ongoing research, enquiry and reflection. Find and evaluate information, using a variety of sources and technologies. Acknowledge the work and ideas of others.	**2 Information literacy, gathering & processing**
Problem solvers Take on challenges and opportunities. Apply creative, logical and critical thinking skills to respond effectively. Make and implement decisions. Be flexible, thorough, innovative and aim for high standards.	**4 Problem solving skills**
Effective communicators Articulate ideas and convey them effectively using a range of media. Work collaboratively and engage with people in different settings. Recognize how culture can shape communication.	**5 Written communication** **6 Oral communication** **7 Teamwork**
Responsible Understand how decisions can affect others and make ethically informed choices. Appreciate and respect diversity. Act with integrity as part of local, national, global and professional communities.	**10 Sustainability, societal & environmental impact**

Practical work:

N.A.

Lecture/tutorial times

Attendance Requirements

The University norms states that it is the responsibility of students to attend all lectures, tutorials, seminars and practical work as stipulated in the course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for semester examinations.

Details of referencing system to be used in written work

Text books

1. Non-Conventional Energy Resources, S. Hasan Saeed and D.K. Sharma, 4th Edition, Katson Books, 2017 .

2. Non-Conventional Energy Resources, S.K. Dubey and S.K. Bhargava, 2nd Edition, Dhanpat Rai & Co., 2014.

Additional Materials

1. Wind and Solar Power Systems, Mukund R. Patel, CRC Press, 1999.
2. Energy Technology, S. Rao. & S. Parulekar, Khanna publishers, Fourth edition, 2005.
3. Non- Conventional Resources of Energy, G.D. Rai, Khanna Publishers, Fourth edition, 2010.
4. Renewable Energy Sources and Conversion Techniques, N.K. Bansal, Kleeman and Melissa, Tata McGraw Hill, 1990.

Web Resource

Renewable Energy Source, Science Direct

1. Link: https://www.sciencedirect.com/topics/earth-and-planetary-sciences/renewable-energy-source.

What Is a Renewable Energy Source? - Definition & Example

2. Link: https://study.com/academy/lesson/what-is-a-renewable-energy-source-definition-example-quiz.html.

MOOCS:

Energy Principles and Renewable Energy, edX, The University of Queensland, Australia

1. Link: https://www.edx.org/course/energy-principles-and-renewable-energy-2

ASSESSMENT GUIDELINES

Your final course mark will be calculated from the following:

40 marks - mid semester examination
20 marks- internal assessment evaluation

Internal Assessment of 20 marks will include:
Attendance : 05 marks bonus (for all students having attendance >80%)
Presentation: 05 marks
Assignment : 10 marks

End Semester Exam: 40 marks.

SUPPLEMENTARY ASSESSMENT

Students who receive an overall mark less than 40% in internal component or less than 40% in the end semester will be considered for supplementary assessment in the respective components (i.e internal component or end semester) of semester concerned. Students must make themselves available during the supplementary examination period to take up the respective components (internal component or end semester) and need to obtain the required minimum 40% marks to clear the concerned components.

For remedial and repeater remedial - CIE 60 marks (40 marks remedial mid semester examination + 20 marks for assignments or case studies, limited to minimum 04 assignments per course).

Practical Work Report/Laboratory Report:

N.A.

Late Work

Late assignments will not be accepted without supporting documentation. Late submission of the reports will result in a deduction of -% of the maximum mark per calendar day

Format

All assignments must be presented in a neat, legible format with all information sources correctly referenced. **Assignment material handed in throughout the session that is not neat and legible will not be marked and will be returned to the student.**

Retention of Written Work

Written assessment work will be retained by the Course coordinator/lecturer for two weeks after marking to be collected by the students.

University and Faculty Policies

Students should make themselves aware of the University and/or Faculty Policies regarding plagiarism, special consideration, supplementary examinations and other educational issues and student matters.

Plagiarism - Plagiarism is not acceptable and may result in the imposition of severe penalties. Plagiarism is the use of another person's work, or idea, as if it is his or her own - if you have any doubts at all on what constitutes plagiarism, please consult your Course coordinator or lecturer. Plagiarism will be penalized severely.

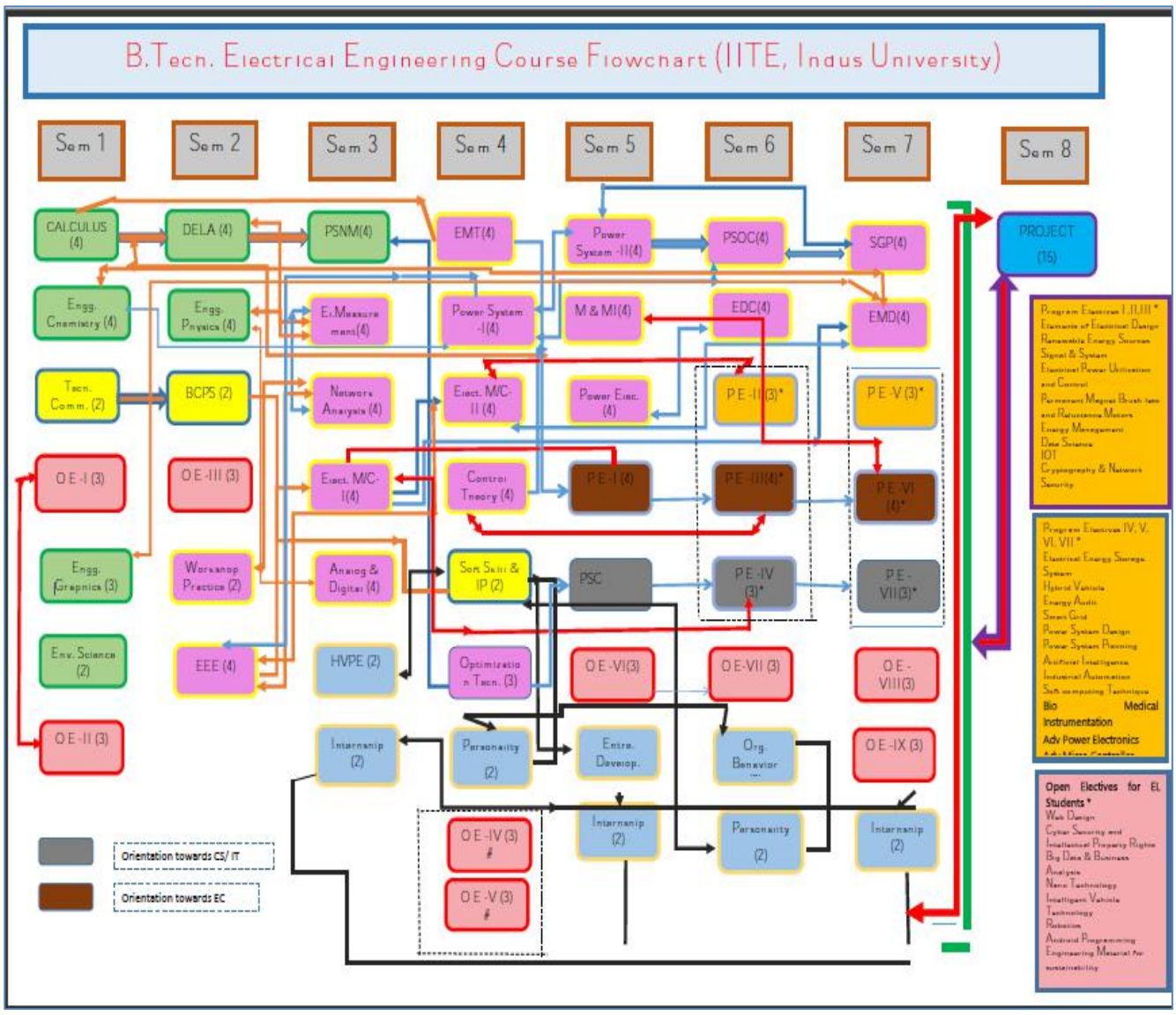
Do not copy the work of other students.
Do not share your work with other students (except where required for a group activity or assessment

Course schedule (subject to change)

(Mention quiz, assignment submission, breaks etc as well in the table under the Teaching Learning Activity Column)

	Week #	Topic & contents	CO Addressed	Teaching Learning Activity (TLA)
	Weeks 1	Introduction to Non-Conventional Energy Resources Overview, Different Forms of Energy, Classification of Energy Resources, Availability of Conventional Energy Sources, Classification of Non-Conventional Energy Resources, Recent Technologies Developed.	1	BB, PPT
	Weeks 2	Geothermal Energy Different Parts of Internal Structure of Earth, Geothermal Energy,	2	BB, PPT
	Week 3	Thermal Gradient, Resources of Geothermal Energy, Vapour Dominated Power Plant, Liquid Dominated Systems	*2*	BB, PPT
	Week 4	Merits, Demerits and Application of Geothermal Power Generation	2	BB, PPT
	Week 5	Solar Cell Overview, Semiconductor Materials, P-N Junction, Theory of Solar Cells, V-I Characteristics of Solar Cell,	3	BB, PPT
	Week 6	Solar Cell Materials, Performance Analysis, Different Types of Solar Cell, Solar Cell Power Plants, Solar Modules and Solar Arrays,	*3*	BB, PPT
	Week 7	Solar Collectors- Flat Plate and Concentrating Collectors, Solar Power	3,	BB, PPT

		Towers		
	Week 8	Wind Energy Overview, Wind Power, Power Extracted by Wind Turbine (Momentum Theory), Optimization of Turbine Power	4	BB, PPT
	Week 9	Aerodynamic Consideration in Design, The Wind Resources and Its Variation with Height, Types of Wind Turbine, Parts of Wind Turbine,	*4*	BB, PPT
	Week 10	Control System of the Wind Turbine, Power Generation Method, Operational Characteristics,	4	BB, PPT
	Week 11	Turbine Siting, Applications, Advantages and Disadvantages of Wind Energy	4	BB, PPT
	Week 12	Ocean Thermal Energy Conversion Introduction, Working Principle of Ocean Thermal Energy Conversion (OTEC) Plant, Location of OTEC System,	5	BB, PPT
	Week 13	Various OTEC Systems – Open Cycle, Closed Cycle, Hybrid Cycle, Advantages, Disadvantages, Limitations and Environmental Impacts of OTEC System	5	BB, PPT
	Week 14	Tidal Energy Working Principle of Tidal Plants, Tidal Energy Conversion Scheme, Advantages and disadvantages of Tidal Plants	6	BB, PPT
	Week 15	Economic and Environmental Considerations, Site Selection of Tidal Plant	6	BB, PPT


B.Tech. Electrical Engineering Course Flowchart (IITE, Indus University)
Sem 1
Sem 2
Sem 3
Sem 4
Sem 5
Sem 6
Sem 7
Sem 8
CALCULUS (4)
DELA (4)
PSNM(4)
EMT(4)
Power System -II(4)
PSOC(4)
SGP(4)
PROJECT (15)
Engg. Chemistry (4)
Engg. Physics (4)
E.Measurements(4)
Power System -I(4)
M & MI(4)
EDC(4)
EMD(4)
Tech. Comm. (2)
BCPS (2)
Network Analysis (4)
Elect. M/C-II (4)
Power Elec. (4)
PE-II (3)*
PE-V (3)*
OE-I (3)
OE-III (3)
Elect. M/C-I(4)
Control Theory (4)
PE-I (4)
PE-III(4)*
PE-VI (4)*
Engg. Graphics (3)
Workshop Practice (2)
Analog & Digital (4)
Soft Skill & IP (2)
PSC
PE-IV (3)*
PE-VII(3)*
Env. Science (2)
EEE (4)
HVPE (2)
Optimization Tech. (3)
OE-VI(3)
OE-VII (3)
OE-VIII(3)
OE-II (3)
Internship (2)
Personality (2)
Entre. Develop.
Org Behavior
OE-IX (3)
OE-IV (3) #
OE-V (3) #
Internship (2)
Personality (2)
Internship (2)
Orientation towards CS/ IT
Orientation towards EC
Program Electives I, II, III *
Elements of Electrical Design
Renewable Energy Sources
Signal & System
Electrical Power Utilization and Control
Permanent Magnet Brushless and Reluctance Motors
Energy Management
Data Science
IOT
Cryptography & Network Security
Program Electives IV, V, VI, VII *
Electrical Energy Storage System
Hybrid Vehicle
Energy Audit
Smart Grid
Power System Design
Power System Planning
Artificial Intelligence
Industrial Automation
Soft computing Techniques
Bio Medical Instrumentation
Adv Power Electronics
Open Electives for EL Students *
Web Design
Cyber Security and Intellectual Property Rights
Big Data & Business Analysis
Nano Technology
Intelligent Vehicle Technology
Robotics
Android Programming
Engineering Material for sustainability

Subject: Renewable Energy Sources								
Program: B.Tech. Electrical Engineering				Subject Code: EL0520				Semester: V
Teaching Scheme				Examination Evaluation Scheme				
Lecture	Tutorial	Practical	Credits	University Theory Examination	University Practical Examination	Continuous Internal Evaluation (CIE)- Theory	Continuous Internal Evaluation (CIE)- Practical	Total
3	1	0	4	40	0	60	0	100

Perquisites:

1. Knowledge of Conventional Sources of Energy
2. Knowledge of Basic Structure of Energy Flow in Power Network

Course Objective:

1. To Study the Available Renewable Sources
2. To Study the Energy Generation the Solar Cells and Plants
3. To Study the concepts of wind power conversion
4. To study the energy conversion from ocean energy

Course Outcome:

After studying this subject, Student will able to,

1. Identify the potential energy sources available in world
2. Understand the concept of conversion of Geothermal energy
3. Understand the concept of conversion of Solar energy
4. Understand the concept of conversion of Wind energy
5. Understand the concept of conversion of Ocean energy
6. Understand the concept of conversion of Tidal energy

SYLLABUS

UNIT-I **[13]**

Introduction to Non-Conventional Energy Resources

Overview, Different Forms of Energy, Classification of Energy Resources, Availability of Conventional Energy Sources, Classification of Non-Conventional Energy Resources, Recent Technologies Developed

Geothermal Energy

Different Parts of Internal Structure of Earth, Geothermal Energy, Thermal Gradient, Resources of Geothermal Energy, Vapour Dominated Power Plant, Liquid Dominated Systems, Merits, Demerits and Application of Geothermal Power Generation

UNIT-II **[10]**

Solar Cell

Overview, Semiconductor Materials, P-N Junction, Theory of Solar Cells, V-I Characteristics of Solar Cell, Solar Cell Materials, Performance Analysis, Different Types of Solar Cell, Solar Cell Power Plants, Solar Modules and Solar Arrays, Solar Collectors- Flat Plate and Concentrating Collectors, Solar Power Towers

UNIT-III **[11]**

Wind Energy

Overview, Wind Power, Power Extracted by Wind Turbine (Momentum Theory), Optimization of Turbine Power, Aerodynamic Consideration in Design, The Wind Resources and Its Variation with Height, Types of Wind Turbine, Parts of Wind Turbine, Control System of the Wind Turbine, Power Generation Method, Operational Characteristics, Turbine Siting, Applications, Advantages and Disadvantages of Wind Energy

UNIT-IV **[11]**

Ocean Thermal Energy Conversion

Introduction, Working Principle of Ocean Thermal Energy Conversion (OTEC) Plant, Location of OTEC System, Various OTEC Systems – Open Cycle, Closed Cycle, Hybrid Cycle, Advantages, Disadvantages, Limitations and Environmental Impacts of OTEC System

Tidal Energy

Working Principle of Tidal Plants, Tidal Energy Conversion Scheme, Advantages and disadvantages of Tidal Plants, Economic and Environmental Considerations, Site Selection of Tidal Plant

Text Books

i) Non-Conventional Energy Resources, S. Hasan Saeed and D.K. Sharma, 4th Edition, Katson Books, 2017 .
ii) Non-Conventional Energy Resources, S.K. Dubey and S.K. Bhargava, 2nd Edition, Dhanpat Rai & Co., 2014.

Reference Book

i) Wind and Solar Power Systems, Mukund R. Patel, CRC Press, 1999.
ii) Energy Technology, S. Rao. & S. Parulekar, Khanna publishers, Fourth edition, 2005.
iii) Non- Conventional Resources of Energy, G.D. Rai, Khanna Publishers, Fourth edition, 2010.
iv) Renewable Energy Sources and Conversion Techniques, N.K. Bansal, Kleeman and Melissa,

Tata McGraw Hill, 1990.

Web Resource

i) Renewable Energy Source, Science Direct
Link: https://www.sciencedirect.com/topics/earth-and-planetary-sciences/renewable-energy-source

ii) What Is a Renewable Energy Source? - Definition & Example
Link: https://study.com/academy/lesson/what-is-a-renewable-energy-source-definition-example-quiz.html

MOOCS:

i) Energy Principles and Renewable Energy, edX, The University of Queensland, Australia
Link: https://www.edx.org/course/energy-principles-and-renewable-energy-2