IV Year II Semester

S.No.	Course Code	Course	Hour /Week			
			L	T	P/D	C
1	ME138B	Renewable Energy Sources	3	-	-	3
2	EE131	High Voltage DC Transmission	3	-	-	3
3	EE134	Electrical Distribution Systems	3	-	-	3
4	EE140	Technical Seminar	-	-	2	1
5	EE141	Major Project / Practice School	-	-	-	14
Total						**24**

Course Plan

Semester: **8 - Semester**	Year: **2019**
Course Title: **Renewable Energy Sources**	Course Code: **ME138B**
Total Contact Hours: **45**	Duration of Theory: 3 Hours
Theory Marks: **70**	Term Work Marks: **10**
Lesson Plan Author: Dr. Subrahmanyam KBVSR	Last Modified Date: 28-07-2018
Checked By: Mr. HOD Electrical	Last Reviewed Date: 22-08-2018

Course Outcomes (COs):

At the end of the course the student should be able to:

1. Classify different types of solar energy collectors.
2. List the applications of solar energy.
3. Discuss the importance of wind energy and biomass energy.
4. Analyze the methods of harnessing the energy.
5. Explain the need for direct energy conversion

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Title: Renewable Energy Sources New	Semester: 8 - Semester
Course Code: ME138B	Year: 2019

Course Outcomes (COs) / Program Outcomes (POs)	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1. Classify different types of solar energy collectors.	2	1		2								2		3	
2. List the applications of solar energy.	2	2		2								2		3	
3. Discuss the importance of wind energy and biomass energy.	2	1		2								2		3	
4. Analyze the methods of harnessing the energy.	2	1		2		2						2		3	
5. Explain the need for direct energy conversion	2	1		1		1						2		3	

Course Content

Course Code: ME138B	Course Title: Renewable Energy Sources New	
L-T-P: 3-0-0	Credits: 3	Contact Hrs: 45
Term Work Marks: 10	Theory Marks: 70	Total Marks: 100
Teaching Hrs: 45		Exam Duration: 3 hrs

Content	Hrs
Unit - 1	
Chapter No. 1 - Principles of Solar Radiation and Solar Energy Collectors Role and potential of new and renewable energy sources. Environmental impact of solar energy, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on tilted surface. Flat plate and concentrating collectors; classification of concentrating collectors.	13.00 hrs
Unit - 2	
Chapter No. 2 - Solar Energy Storage and Applications Different methods of storage - Sensible, latentheat, stratified and solar ponds.	12.00 hrs

Solar Applications- solar heating and cooling techniques, solar distillation and drying, photo voltaic energy conversion.	
Unit - 3	
Chapter No. 3 - Wind Energy and Bio Sources and potential, horizontal and vertical axis windmills, performance characteristics, Betz criteria. Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C.Engine operation and economic aspects.	10.00 hrs
Unit - 4	
Chapter No. 4 - Geothermal Energy and Ocean Energy Resources, types of wells, methods of harnessing the energy, potential in India. OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, minihydel power plants, and their economics.	10.00 hrs
Unit - 5	
Chapter No. 5 - Direct Energy Conversion Need for DEC, Carnot cycle, limitations, principles of DEC. Thermo-electric generators, Seebeck, Peltier and Joule Thomson effects, Figure of merit, materials, applications, MHD generators, principles, dissociation and ionization, Hall effect, magnetic flux, MHD accelerator, MHD Engine, power generation systems, electron gas dynamic conversion, economic aspects. Fuel cells, principles, Faraday's laws,thermodynamic aspects, selection of fuels and operating conditions.	10.00 hrs

Text Books (List of books as mentioned in the approved syllabus)

1. Tiwari and Ghosal, Renewable Energy Resources, 1st Edition, Narosa Publications, 2007., 2007
2. G.D. Rai, Non-Conventional Energy Sources, 2, Standards Publishers, 2004

References

1. Sukhatme, Solar Energy, 3, Tata McGraw Hill, 2008
2. Ashok V Desai, Non-Conventional Energy, 2, New Age International, 2008
3. B.H. Khan, Non Conventional Energy Sources, 1, Tata McGraw Hill, 2009
4. J.A. Duffie and W.A. Beckman, Solar Energy- Thermal Processes, John Wiley, 2001

Evaluation Scheme

Term Work Scheme

Assessment	Weightage in Marks
Mid Term 1	20
Mid Term 2	20
Assignment	5
Attendance	5
Term End Exam	70
Total	**120**

Course Unitization for Minor Exams and Semester End Examination

Topics / Chapters	Teaching Credits	No. of Questions in Mid Term 1	No. of Questions in Mid Term 2	No. of Questions in Assignment	No. of Questions in Attendance	No. of Questions in Term End Exam
Unit I						
1 - Principles of Solar Radiation and Solar Energy Collectors	13.00	5.00	--	5.00	--	3.00
Unit II						
2 - Solar Energy Storage and Applications	12.00	7.00	--	5.00	--	4.00
Unit III						
3 - Wind Energy and Bio	10.00	3.00	3.00	5.00	3.00	4.00
Unit IV						
4 - Geothermal Energy and Ocean Energy	10.00	--	7.00	5.00	7.00	4.00
Unit V						
5 - Direct Energy Conversion	10.00	--	5.00	5.00	5.00	3.00

Note

1. Each Question carries 20 marks and may consists of sub-questions.
2. Mixing of sub-questions from different chapters within a unit (only for Unit I and Unit II) is allowed in Minor I, II and Theory.
3. Answer 5 full questions of 20 marks each (two full questions from Unit I, II and one full questions from Unit III) out of 8 questions in Theory.

Date: **Head of Department**

Chapterwise Plan

Course Code and Title: **ME138B / Renewable Energy Sources New**	
Chapter Number and Title: **1 - Principles of Solar Radiation and Solar Energy Collectors**	Planned Hours: **13.00 hrs**

Learning Outcomes:-

At the end of the topic the student should be able to:

	Topic Learning Outcomes	COs	BL
1	Outline the energy demand of world, nation and available resources to fulfill the demand.	CO1	L2
2	Classify solar energy collectors.	CO2	L2,L4

Lesson Schedule

Lecture No. - Portion covered per hour	Planned Delivery Date	Actual Delivery Date
1. Role and potential of new and renewable energy sources.	20-11-2018	20-11-2018
2. Environmental impact of solar energy	20-11-2018	20-11-2018
3. physics of the sun	20-11-2018	20-11-2018
4. the solar constant, extraterrestrial solar radiation,	27-11-2018	27-11-2018
5. solar radiation on tilted surface.	28-11-2018	28-11-2018
6. Flat plate and concentrating collectors	04-12-2018	04-12-2018
7. Flat plate and concentrating collectors continuation	05-12-2018	05-12-2018
8. classification of concentrating collectors.	11-12-2018	11-12-2018
9. review and discussion	12-12-2018	12-12-2018

Review Questions

Sl.No. - Questions	TLOs	BL
1. NULL explainEnvironmental impact of solar energy	TLO1	L2
2. NULL classification of concentrating collectors.	TLO2	L2

Course Code and Title: **ME138B / Renewable Energy Sources New**	
Chapter Number and Title: **2 - Solar Energy Storage and Applications**	Planned Hours: **12.00 hrs**

Learning Outcomes:-

At the end of the topic the student should be able to:

	Topic Learning Outcomes	COs	BL
1	Compare the technologies that are used to harness the power of solar energy	CO1	L5
2	Illustrate the applications of solar energy.	CO2	L2

Lesson Schedule

Lecture No. - Portion covered per hour	Planned Delivery Date	Actual Delivery Date
1. Solar Energy Storage and Applications: Different methods of storage	18-12-2018	18-12-2018
2. Sensible, latent heat, stratified and solar ponds.	19-12-2018	19-12-2018
3. Solar Applications	19-12-2018	19-12-2018
4. solar heating and cooling techniques	02-01-2019	02-01-2019
5. solar heating and cooling techniques continuation	08-01-2019	08-01-2019
6. solar distillation and drying	09-01-2019	09-01-2019
7. photovoltaic energy conversion.	09-01-2019	09-01-2019
8. Discussion about the unit	09-01-2019	09-01-2019

Review Questions

Sl.No. - Questions	TLOs	BL
1. NULL classifydifferent Solar Energy Storage methods.	TLO2	L2
2. explain photovoltaic energy conversion NULL	TLO1	L5

Course Code and Title: **ME138B / Renewable Energy Sources New**	
Chapter Number and Title: **3 - Wind Energy and Bio**	Planned Hours: **10.00 hrs**

Learning Outcomes:-

At the end of the topic the student should be able to:

	Topic Learning Outcomes	COs	BL
1	Identify the importance of wind energy and biomass energy.	CO3	L3

Lesson Schedule

Lecture No. - Portion covered per hour	Planned Delivery Date	Actual Delivery Date
1. Wind Energy: Sources and potential	22-01-2019	22-01-2019
2. horizontal and vertical axis windmills	23-01-2019	23-01-2019
3. horizontal and vertical axis windmills continuation	29-01-2019	29-01-2019
4. performance characteristics	30-01-2019	30-01-2019
5. Betz criteria	05-02-2019	05-02-2019
6. Principles of Bio-Conversion	06-02-2019	06-02-2019
7. Anaerobic/aerobic digestion	12-02-2019	12-02-2019
8. types of Biogas digesters, gas yield, combustion characteristics of bio-gas	13-02-2019	13-02-2019
9. utilization for cooking, I.C. Engine operation and economic aspects.	13-02-2019	13-02-2019
10. Discussion about the unit	13-02-2019	13-02-2019

Review Questions

Sl.No. - Questions	TLOs	BL
1. NULL construct and explain in detail abouthorizontal and vertical axis windmills.	TLO1	L3
2. NULL discuss different types of Biogas digesters.		

Course Code and Title: **ME138B / Renewable Energy Sources New**	
Chapter Number and Title: **4 - Geothermal Energy and Ocean Energy**	Planned Hours: **10.00 hrs**

Learning Outcomes:-

At the end of the topic the student should be able to:

	Topic Learning Outcomes	COs	BL
1	Explain the importance of geothermal energy and ocean energy.	CO4	L5

Lesson Schedule

Lecture No. - Portion covered per hour	Planned Delivery Date	Actual Delivery Date
1. Geothermal Energy and Ocean Energy: Resources, types of wells, methods of harnessing the energy	19-02-2019	19-02-2019
2. OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles.	20-02-2019	20-02-2019
3. Tidal and wave energy: Potential and conversion techniques	20-02-2019	20-02-2019
4. minihydel power plants, and their economics.	26-02-2019	26-02-2019
5. Assignment-2	27-02-2019	27-02-2019

Review Questions

Sl.No. - Questions	TLOs	BL
1. importance ofGeothermal Energy and Ocean Energy NULL	TLO1	L5

Course Code and Title: **ME138B / Renewable Energy Sources New**	
Chapter Number and Title: **5 - Direct Energy Conversion**	Planned Hours: **10.00 hrs**

Learning Outcomes:-

At the end of the topic the student should be able to:

	Topic Learning Outcomes	COs	BL
1	Define the principles of direct energy conversion.	CO5	L1
2	List out various types of fuel cells.	CO5	L1

Lesson Schedule

Lecture No. - Portion covered per hour	Planned Delivery Date	Actual Delivery Date
1. Need for DEC, Carnot cycle,	05-03-2019	05-03-2019
2. Limitations, principles of DEC.,Thermo-electric generators, seeback ,peltier and joule thomsons effect.	05-03-2019	05-03-2019
3. Materials, applications,MHD generators, principles,dissociation and ionisation	06-03-2019	06-03-2019
4. Hall effect, magnetic flux, MHD accelerator, MHD Engine	06-03-2019	06-03-2019
5. power generation systems, electron gas dynamic conversion, economic aspects.	06-03-2019	06-03-2019
6. Fuel cells, principles, Faraday’s laws, thermodynamic aspects	12-03-2019	12-03-2019
7. selection of fuels and operating conditions.	12-03-2019	12-03-2019
8. Discussion about the unit	13-03-2019	13-03-2019
9. Revision of all topics	13-03-2019	13-03-2019

Review Questions

Sl.No. - Questions	TLOs	BL
1. What is the importance of MHD generators NULL	TLO2	L1
2. NULL define Seebeck, Peltier and Joule Thomson effects.	TLO1	L1

Question Paper Title: IV B.TECH. I SEM. (RA13) REGULAR EXAMINATIONS, OCT/NOV – 2016		
Total Duration (H:M): 3	**Course: Renewable Energy Sources New (ME138B)**	**Maximum Marks: 70**
Note: Answer all questions in Part-A and any 5 questions in Part-B		

A				
Q.No.	**Questions**	**Marks**	**CO**	**BL**
1	Briefly explain the impact of solar power on environment	0.50	CO1,	
2	Differentiate Flat collector and concentrating collector	0.50	CO1,	
3	What is meant by Photovoltaic Energy Conversion?	0.50	CO2,	
4	Explain the non-convective solar ponds.	0.50	CO2,	
5	Describe the potential for wind power	0.50	CO3,	
6	Classify wind energy sources	0.50	CO3,	
7	What is meant by aerobic digestion?	0.50	CO3,	
8	Explain different methods of energy extraction from biomass	0.50	CO3,	
9	List the advantages of OTEC systems	0.50	CO4,	
10	What is the potential to geothermal energy?	0.50	CO4,	

B				
Q.No.	**Questions**	**Marks**	**CO**	**BL**
11	What is a solar constant. Differentiate direct and diffused solar radiation. \n b) Explain in detail about the liquid flat plate collector.	10.00	CO1,	
12	Discuss in detail the various parameters to be considered in detail for the design of solar water heating system and its efficiency. \n b) Explain in detail about the solar distillation process	10.00	CO2,	
13	Explain various types of vertical axis wind turbines. \n b) Define power coefficient of a wind turbine and prove that its maximum value is 59%.	10.00	CO3,	
14	What are the different methods of Biomass	10.00	CO3,	

	conversion technique and describe them briefly. \n b) Discuss about the sensible and latent heat storage system.			
15	Explain the working principle of MHD conversion with neat block diagram. \n b) Explain the various types of thermo electric effects.	10.00	CO5,	
16	Explain the various characteristics of wind and variation with respect to height, pressure, temperature and time. \n b) Describe various type of pyrheliometer used to measure solar radiation.	10.00	CO3,	
17	What is OTEC system? Explain open and closed cycles of operation of OTEC systems. \n b) Discuss about the double basin arrangement of tidal cycle.	10.00	CO4,	
18	What is the principle of solar photovoltaic power generation? What are the main elements of a PV system? Derive IV relation and draw the characteristics. \n b) Write the merits and demerit and application of a PV system.	10.00	CO2,	

FMTH0301/Rev.5.2

Course Plan

Semester: **8 - Semester**	Year: **2019**
Course Title: **HVDC Transmission**	Course Code: **EE131**
Total Contact Hours: **45**	Duration of Theory: 3 Hours
Theory Marks: **70**	Term Work Marks: **10**
Lesson Plan Author: Mr. Chandan Shiva	Last Modified Date: 28-07-2018
Checked By: Mr. HOD Electrical	Last Reviewed Date: 30-11-2018

Course Outcomes (COs):

At the end of the course the student should be able to:

1. Explain the advantages, limitations, and applications of hvdc system.
2. Evaluate the configuration and operation of rectifier and inverter operation.
3. Explain the control of hvdc converters and systems.
4. Analyze the configurations of multi-terminal dc links, operation and control.
5. Evaluate the converter faults and protection in hvdc systems.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Title: HVDC Transmission	Semester: 8 - Semester
Course Code: EE131	Year: 2019

Course Outcomes (COs) / Program Outcomes (POs)	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1. Explain the advantages, limitations, and applications of hvdc system.	**1**	**1**	**1**												
2. Evaluate the configuration and operation of rectifier and inverter operation.	**2**	**1**			**2**										
3. Explain the control of hvdc converters and systems.	**2**	**1**	**1**		**1**										
4. Analyze the configurations of multi-terminal dc links, operation and control.	**1**		**2**		**1**										
5. Evaluate the converter faults and protection in hvdc systems.	**2**		**2**		**1**										

Course Content

Course Code: EE131	Course Title: HVDC Transmission	
L-T-P: 3-0-0	Credits: 3	Contact Hrs: 45
Term Work Marks: 10	Theory Marks: 70	Total Marks: 90
Teaching Hrs: 45		Exam Duration: 3 hrs

Content	Hrs
Unit - 1	
Chapter No. 1 - HVDC Transmission General considerations, Power Handling Capabilities of HVDC Lines, Basic Conversion principles, static converter configuration.	2.00 hrs
Unit - 2	

Chapter No. 2 - Static Power Converters 3-pulse, 6-pulse and 12-pulse converters, converter station and Terminal equipment, commutation process, Rectifier and inverter operation, equivalent circuit for converter -special features of converter transformers. Harmonics in HVDC Systems, Harmonic elimination, AC and DC filters.	7.00 hrs
Unit - 3	
Chapter No. 3 - Control of HVDC Converters and Systems constant current, constant extinction angle and constant Ignition angle control-Individual phase control and equidistant firing angle control, DC power flow control. Interaction between MV AC and DC systems - Voltage interaction, Harmonic instability problems and DC power modulation.	6.00 hrs
Unit - 4	
Chapter No. 4 - Multi-Terminal DC Links and Systems series, parallel and series parallel systems, their operation and control. Transient over voltages in HVDC systems: Over voltages due to disturbances on DC side, over voltages due to DC and AC side line faults.	7.00 hrs
Unit - 5	
Chapter No. 5 - Converter Faults and Protection in HVDC Systems Converter faults, over current protection - valve group, and DC line protection. Over voltage protection of converters, surge arresters.	6.00 hrs

Text Books (List of books as mentioned in the approved syllabus)

1. E.W. Kimbark, Direct current Transmission, Wiely Inter Science, New York
2. J. Arilaga, HVDC Transmission, Peter Peregrinus Ltd., London, 1983

References

1. K.R. Padiyar, High Voltage Direct Current Transmission, Wiely Eastern Ltd., New Delhi, 1992
2. E. Uhlman, Power Transmission by Direct Current, Springer Verlag, Berlin, 1985

Evaluation Scheme

Term Work Scheme

Assessment	Weightage in Marks
Mid Term1	20
Mid Term2	20
Assignment 1	10
Assignment 2	10
Term End Exam	70
Total	**130**

Course Unitization for Minor Exams and Semester End Examination

Topics / Chapters	Teaching Credits	No. of Questions in Mid Term1	No. of Questions in Mid Term2	No. of Questions in Assignment 1	No. of Questions in Assignment 2	No. of Questions in Term End Exam
Unit I						
1 - HVDC Transmission	2.00	2.00	--	5.00	--	1.00
Unit II						
2 - Static Power Converters	7.00	3.00	--	5.00	--	2.00
Unit III						
3 - Control of HVDC Converters and Systems	6.00	--	1.00	--	2.00	2.00
Unit IV						
4 - Multi-Terminal DC Links and Systems	7.00	--	2.00	--	4.00	2.00
Unit V						
5 - Converter Faults and Protection in HVDC Systems	6.00	--	2.00	--	4.00	1.00

Note

1. Each Question carries 20 marks and may consists of sub-questions.
2. Mixing of sub-questions from different chapters within a unit (only for Unit I and Unit II) is allowed in Minor I, II and Theory.
3. Answer 5 full questions of 20 marks each (two full questions from Unit I, II and one full questions from Unit III) out of 8 questions in Theory.

Date: **Head of Department**

Chapterwise Plan

Course Code and Title: **EE131 / HVDC Transmission**	
Chapter Number and Title: **1 - HVDC Transmission**	Planned Hours: **2.00 hrs**

Learning Outcomes:-

At the end of the topic the student should be able to:

	Topic Learning Outcomes	COs	BL
1	**Analyze** the functioning of the HVDC System.	CO1	L1,L2
2	**Discuss** the advantages and applications of the HVDC system.	CO1	L2
3	**Identify** the different types of HVDC systems.	CO2	L1
4	**Study** the static converter configuration.	CO2	L1

Lesson Schedule

Lecture No. - Portion covered per hour	Planned Delivery Date	Actual Delivery Date
1. General considerations	27-11-2018	27-11-2018
2. Power handling capabilities of HVDC lines	27-11-2018	27-11-2018
3. Basic conversion principles	03-12-2018	03-12-2018
4. Static converter configuration	03-12-2018	03-12-2018

Review Questions

Sl.No. - Questions	TLOs	BL
1. How does HVDC work.	TLO1	L1
2. How does HVDC system differ from the existing AC transmission system.	TLO1	L2
3. Outline the problem of AC interconnection systems.	TLO1	L1
4. What is the need for interconnection of systems.	TLO1	L2
5. Define a converter station.	TLO1	L1
6. Summarize the disadvantages of HVDC system.	TLO1	L1

Course Code and Title: **EE131 / HVDC Transmission**	
Chapter Number and Title: **2 - Static Power Converters**	Planned Hours: **7.00 hrs**

Learning Outcomes:-

At the end of the topic the student should be able to:

	Topic Learning Outcomes	COs	BL
1	Study of 3-pulse, 6-pulse, and 12-pulse converters.	CO2	L1
2	Explain the rectifier and Inverter operation in HVDC system.	CO2	L2
3	Design the equivalent circuit for converters.	CO2	L3
4	List the reasons for harmonics in HVDC system.	CO5	L1

Lesson Schedule

Lecture No. - Portion covered per hour	Planned Delivery Date	Actual Delivery Date
5. 3-pulse and 6-pulse converters	04-12-2018	04-12-2018
6. 12-pulse converters	04-12-2018	04-12-2018
7. Converter station	10-12-2018	10-12-2018
8. Terminal equipment	10-12-2018	10-12-2018
9. Commutation process	11-12-2018	11-12-2018
10. Equivalent circuit for converter	17-12-2018	17-12-2018
11. Special features of converter transformers	17-12-2018	17-12-2018
12. Harmonics in HVDC Systems	18-12-2018	18-12-2018
13. Harmonic elimination	24-12-2018	24-12-2018
14. AC filters	31-12-2018	31-12-2018
15. DC filters	31-12-2018	31-12-2018

Review Questions

Sl.No. - Questions	TLOs	BL
1. Describe the diagram of graetz bridge circuit.	TLO1	L1
2. What is valve utilizing factor.	TLO1	L1
3. With a neat sketch, explain how a converter transformer is responsible for the generation of harmonics.	TLO2	L2
4. Why the filters not needed on the DC side with HVDC voltage source converter scheme.	TLO4	L1
5. Derive the current harmonics generated by 12 pulse operation.	TLO4	L1
6. Why the use of 12 pulse converter is preferable over the six pulses and increase in pulse \n number beyond 12 is not practical.	TLO1	L1

Course Code and Title: **EE131 / HVDC Transmission**	
Chapter Number and Title: **3 - Control of HVDC Converters and Systems**	Planned Hours: **6.00 hrs**

Learning Outcomes:-

At the end of the topic the student should be able to:

	Topic Learning Outcomes	COs	BL
1	Analyze the constant current and constant extinction angle for the HVDC converter.	CO3	L4
2	Describe the DC power flow control method.	CO4	L4
3	Elaborate the concept of harmonic instability.	CO4	L4
4	Explain the methods of DC power modulation.	CO4	L2

Lesson Schedule

Lecture No. - Portion covered per hour	Planned Delivery Date	Actual Delivery Date
16. Constant current	07-01-2019	07-01-2019
17. Constant extinction angle	07-01-2019	07-01-2019
18. Constant Ignition angle control	08-01-2019	08-01-2019
19. Individual phase control and equidistant firing angle control	08-01-2019	08-01-2019
20. DC power flow control	21-01-2019	21-01-2019
21. Interaction between MV AC and DC systems	22-01-2019	22-01-2019
22. Voltage interaction	28-01-2019	28-01-2019
23. Harmonic instability problems	28-01-2019	28-01-2019
24. DC power modulation	29-01-2019	29-01-2019

Review Questions

Sl.No. - Questions	TLOs	BL
1. Show in detail about the converter control characteristics of HVDC system.	TLO1	L4
2. Draw and explain the inverter and rectifier compounding characteristics with constant voltage and current curve.	TLO1	L4
3. Draw the complete converter control characteristics and explain the principle of power control in a DClink.	TLO2	L4
4. What is the order of harmonics present on the AC side of the VSC converter DC system	TLO3	L4
5. Justify the relative merits and demerits of constant current control and constant voltage control of HVDC link.	TLO1	L4

6. Mention block diagram, discuss the principle of operation of a basic power controller.	TLO4	L2

Course Code and Title: **EE131 / HVDC Transmission**	
Chapter Number and Title: **4 - Multi-Terminal DC Links and Systems**	Planned Hours: **7.00 hrs**

Learning Outcomes:-

At the end of the topic the student should be able to:

	Topic Learning Outcomes	COs	BL
1	List the different forms of multi-terminal DC systems.	CO4	L1
2	Explain the operation and control of multi-terminal DC systems.	CO4	L2
3	Analyze the transient overvoltages in HVDC systems.	CO3	L4
4	Determine the overvoltages due to DC side line faults.	CO4	L5

Lesson Schedule

Lecture No. - Portion covered per hour	Planned Delivery Date	Actual Delivery Date
25. Series systems	04-02-2019	04-02-2019
26. Parallel systems	04-02-2019	04-02-2019
27. Series parallel systems	05-02-2019	05-02-2019
28. Operation and control of series systems	05-02-2019	05-02-2019
29. Operation and control of parallel systems	11-02-2019	11-02-2019
30. Transient over voltages in HVDC systems	12-02-2019	12-02-2019
31. Over voltages due to disturbances on DC side	18-02-2019	18-02-2019
32. Over voltages due to DC side line faults	19-02-2019	19-02-2019
33. Over voltages due to AC side line faults	25-02-2019	25-02-2019

Review Questions

Sl. No. - Questions	TLOs	BL
1. Explain control characteristics of parallel connected MTDC systems.	TLO1	L1
2. Mention the importance of multi-terminal DC links.	TLO1	L1
3. Discuss series-parallel multi-terminal HVDC system and its control.	TLO2	L2
4. Discuss the operation of surge arrestors for over voltage protection of HVDC system.	TLO3	L4
5. Explain the nature of transient overvoltages due to disturbances on DC side.	TLO3	L4
6. Discuss the over voltages due to disturbances on DC side.	TLO4	L5

Course Code and Title: **EE131 / HVDC Transmission**	
Chapter Number and Title: **5 - Converter Faults and Protection in HVDC Systems**	Planned Hours: **6.00 hrs**

Learning Outcomes:-

At the end of the topic the student should be able to:

	Topic Learning Outcomes	COs	BL
1	Analyze the faults in HVDC converter System.	CO5	L4
2	Describe the over current and over voltage protection in HVDC system.	CO5	L2
3	Describe the methods of DC line protection.	CO4	L2
4	Classify the importance of the surge arrestor.	CO5	L4

Lesson Schedule

Lecture No. - Portion covered per hour	Planned Delivery Date	Actual Delivery Date
34. Converter faults	26-02-2019	26-02-2019
35. Over current protection	27-02-2019	27-02-2019
36. Valve group	27-02-2019	27-02-2019
37. DC line protection	28-02-2019	28-02-2019
38. Over voltage protection of converters	05-03-2019	05-03-2019
39. Surge arresters	11-03-2019	11-03-2019
40. Revision	12-03-2019	12-03-2019

Review Questions

Sl.No. - Questions	TLOs	BL
1. What are the methods adopting for limiting overvoltage in DC system.	TLO2	L2
2. Explain different kind of switching surges that occur in DC system.	TLO4	L4
3. Explain how the insulation coordination is affected by different types of overvoltages.	TLO2	L2
4. What are the over voltages due to disturbances on AC system side? Explain.	TLO2	L2
5. Explain how transient over voltages are produced due to faults on AC side.	TLO1	L4
6. Explain the different methods for the protection of DC line fault in the HVDC system.	TLO2	L2

Question Paper Title: external		
Total Duration (H:M): 3:00	**Course: HVDC Transmission (EE131)**	**Maximum Marks: 70**
Note: Answer all questions in Part-A and any 5 questions in Part-B		

part a				
Q.No.	**Questions**	**Marks**	**CO**	**BL**
1	Compare HVDC and AC transmission in terms of economy	2.00	CO1,	
2	What are the modern trends in HVDC transmission?	2.00	CO1,	
3	What is the effect of source inductance on HVDC system?	2.00	CO2,	
4	Explain the effect of corona on DC lines.	2.00	CO2,	
5	What are the adverse effects of harmonics?	2.00	CO3,	
6	List out the types of filters used to reduce the harmonics	2.00	CO3,	
7	What is the need of transmission interconnections?	2.00	CO4,	
8	Explain the benefits of FACTS controllers.	2.00	CO4,	
9	What is meant by midpoint voltage regulation?	2.00	CO4,	
10	List out the objectives of series compensation.	2.00	CO5,	

Part b				
Q.No.	**Questions**	**Marks**	**CO**	**BL**
11	Draw the schematic diagram of a HVDC converter station. Explain about the various types of HVDC links.	10.00	CO1,	
12	With neat sketch, explain the characterestics of 12 pulse converter circuit in star-star mode	10.00	CO2,	
13	Explain about the current and extinction angle control of a HVDC converter	10.00	CO2,	
14	Explain the protection against over voltage and over current in converter station	10.00	CO3,	

15	Explain about the types of harmonics introduced by HVDC converter and design the single tuned and high pass filters.	10.00	CO3,	
16	With neat diagrams, explain about the basic types of FACTS controllers	10.00	CO4,	
17	Compare STATCOM and SVC in terms of their characteristics and transient stability.	10.00	CO5,	
18	Explain the operating principle of Thyristor Switched Series Capacitor (TSSC) and Thyristor Controlled Series Capacitor (TCSC)	10.00	CO5,	

FMTH0301/Rev.5.2

Course Plan

Semester: **8 - Semester**	Year: **2019**
Course Title: **Electrical Distribution Systems**	Course Code: **EE134**
Total Contact Hours: **45**	Duration of Theory: 3 Hours
Theory Marks: **70**	Term Work Marks: **10**
Lesson Plan Author: Dr. Vedik Basetti	Last Modified Date: 28-07-2018
Checked By: Mr. HOD Electrical	Last Reviewed Date: 22-08-2018

Course Outcomes (COs):

At the end of the course the student should be able to:

1. Explain the relation between load factor and loss factor.
2. Design a radial and loop type distribution feeders.
3. Calculate the voltage drop and power loss in a distribution system.
4. Analyze the coordination between various protective devices.
5. Design a suitable capacitance for voltage control in a distribution system.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Title: Electrical Distribution Systems	Semester: 8 - Semester
Course Code: EE134	Year: 2019

Course Outcomes (COs) / Program Outcomes (POs)	1	2	3	4	5	6	7	8	9	10	11	12	PSO 1	PSO 2
1. Explain the relation between load factor and loss factor.	2	1	-	-	-	-	-	-	-	-	-	-	-	-
2. Design a radial and loop type distribution feeders.	2	-	2	-	-	-	-	-	-	-	-	-	2	-
3. Calculate the voltage drop and power loss in a distribution system.	2	2	2	-	-	-	-	-	-	-	-	-	-	-
4. Analyze the coordination between various protective devices.	2	2	2	-	-	-	-	-	-	-	-	-	3	-
5. Design a suitable capacitance for voltage control in a distribution system.	3	3	2	-	-	-	-	-	-	-	-	-	3	-

Course Content

Course Code: EE134	Course Title: Electrical Distribution Systems	
L-T-P: 3-0-0	Credits: 3	Contact Hrs: 45
Term Work Marks: 10	Theory Marks: 70	Total Marks: 100
Teaching Hrs: 45		Exam Duration: 3 hrs

Content	Hrs
Unit - 1	
Chapter No. 1 - General Concept Introduction to distribution systems, Load modeling and characteristics. Coincidence factor, contribution factor, loss factor - Relationship between the load factor and loss factor. Classification of loads (Residential, commercial, Agricultural and Industrial) and their characteristics	6.00 hrs
Unit - 2	
Chapter No. 2 - Distribution Feeders	7.00 hrs

Design Considerations of Distribution Feeders: Radial and loop types of primary feeders, voltage levels, feeder loading; basic design practice of the secondary distribution system.	
Unit - 3	
Chapter No. 3 - Substations and System Analysis Location of Substations: Rating of distribution substation, service area within primary feeders. Benefits derived through optimal location of substations. Voltage drop and power-loss calculations: Derivation for voltage drop and power loss in lines, manual methods of solution for radial networks, three phase balanced primary lines.	9.00 hrs
Unit - 4	
Chapter No. 4 - Protection and Coordination Objectives of distribution system protection, types of common faults and procedure for fault calculations. Protective Devices: Principle of operation of Fuses, Circuit reclosures, line sectionalizes, and circuit breakers. Coordination of Protective Devices: General coordination procedure.	8.00 hrs
Unit - 5	
Chapter No. 5 - Compensation for Power Factor Improvement and Voltage Control Capacitive compensation for power-factor control. Different types of power capacitors, shunt and series capacitors, effect of shunt capacitors. (Fixed and switched), Power factor correction, capacitor allocation - Economic justification - Procedure to determine the best capacitor location. Voltage Control: Equipment for voltage control, effect of series capacitors, effect of AVB/AVR, line drop compensation.	12.00 hrs

Text Books (List of books as mentioned in the approved syllabus)

1. Turan Gonen, "Electric Power Distribution System, Engineering", McGraw Hill Book Company.
2. A.S. Pabla, "Electric Power Distribution", Tata McGraw Hill Publishing Company, 2008.

References

1. S. Sivanagaraju and V. Sankar, "Electrical Power Distribution and Automation", Dhanpat Rai and Co, 2006.
2. V. Kamaraju, "Electrical Power Distribution Systems", 1st ed., Right Publishers, 2009.

Evaluation Scheme

Term Work Scheme

Assessment	Weightage in Marks
MID1	20
MID2	20
Assignment/Attendance	10
TEE	70
Total	**120**

Course Unitization for Minor Exams and Semester End Examination

Topics / Chapters	Teaching Credits	No. of Questions in MID1	No. of Questions in MID2	No. of Questions in Assignment	No. of Questions in TEE
Unit I					
1 – General Concept	6.00	7.00	--	10.00	3.00
Unit II					
2 - Distribution Feeders	7.00	10.00	--	10.00	4.00
Unit III					
3 - Substations and System Analysis	9.00	--	5.00	10.00	4.00
Unit IV					
4 - Protection and Coordination	8.00	--	5.00	10.00	4.00
Unit V					
5 - Compensation for Power Factor Improvement and Voltage Control	12.00	--	5.00	10.00	3.00

Note

1. Each Question carries 20 marks and may consists of sub-questions.
2. Mixing of sub-questions from different chapters within a unit (only for Unit I and Unit II) is allowed in Minor I, II and Theory.
3. Answer 5 full questions of 20 marks each (two full questions from Unit I, II and one full questions from Unit III) out of 8 questions in Theory.

Date: **Head of Department**

Chapter wise Plan

Course Code and Title: **EE134 / Electrical Distribution Systems**	
Chapter Number and Title: **1 - General**	Planned Hours: **6.00 hrs**

Learning Outcomes:-

At the end of the topic the student should be able to:

	Topic Learning Outcomes	COs	BL
1	Describe the load modeling and their characteristics	CO1	L1
2	Define various terms associated with distribution systems	CO1	L1
3	Develop the relationship between the load factor and loss factor.	CO1	L4
4	Classify different types of loads and their characteristics	CO1	L3

Lesson Schedule

Lecture No. - Portion covered per hour	Planned Delivery Date	Actual Delivery Date
1. Introduction to distribution systems	19-11-2018	19-11-2018
2. Load modeling and characteristics	20-11-2018	20-11-2018
3. Coincidence factor, contribution factor, loss factor	26-11-2018	26-11-2018
4. Relationship between the load factor and loss factor.	27-11-2018	27-11-2018
5. Classification of loads (Residential, commercial, Agricultural and Industrial) and their characteristics.	28-11-2018	28-11-2018

Review Questions

Sl.No. - Questions	TLOs	BL
1. NULL 1.Analyze the relationship between the load factor and loss factor.\n2.A substation has a connected load of 45 MW and a Max demand of 22MW, the units supplied being 60 x 106 per annum. Determine i) Load & demand factors.	TLO3	L4

Course Code and Title: **EE134 / Electrical Distribution Systems**	
Chapter Number and Title: **2 - Distribution Feeders**	Planned Hours: **7.00 hrs**

Learning Outcomes:-

At the end of the topic the student should be able to:

	Topic Learning Outcomes	COs	BL
1	Discuss about design Considerations of Distribution Feeders	CO2	L2
2	Explain the factors affecting primary feeder loading.	CO2	L6
3	List the various factors that influence the voltage levels in the design and operation of distribution system	CO3	L1
4	Explain the basic design practice of the secondary distribution system.	CO2	L6

Lesson Schedule

Lecture No. - Portion covered per hour	Planned Delivery Date	Actual Delivery Date
1. Design Considerations of Distribution Feeders	03-12-2018	03-12-2018
2. Radial and loop types of primary feeders	04-12-2018	04-12-2018
2. voltage levels, feeder loading	10-12-2018	10-12-2018
3. basic design practice of the secondary distribution system.	12-12-2018	12-12-2018
3. Radial and loop types of primary feeders	05-12-2018	05-12-2018
4. voltage levels, feeder loading	11-12-2018	11-12-2018
7. basic design practice of the secondary distribution systems	17-12-2018	17-12-2018

Review Questions

Sl.No. - Questions	TLOs	BL
1. NULL Explain the differences between radial and loop types of primary distribution feeder	TLO2	L6
2. NULL List the factors which affect the feeder voltage level	TLO3	L1

Course Code and Title: **EE134 / Electrical Distribution Systems**	
Chapter Number and Title: **3 - Substations and System Analysis**	Planned Hours: **9.00 hrs**

Learning Outcomes:-

At the end of the topic the student should be able to:

	Topic Learning Outcomes	COs	BL
1	List out the aspects to be considered for selecting location of substation	CO4	L1
2	Explain the rating of distribution substation	CO4	L6
3	Analyze the Substation Service area with n primary feeders	CO3	L4
4	Compare 4 and 6 feeder patterns	CO4	L5
5	List the benefits derived through optimal location of substations	CO5	L1

Lesson Schedule

Lecture No. - Portion covered per hour	Planned Delivery Date	Actual Delivery Date
1. Location of Substations	18-12-2018	18-12-2018
2. Rating of distribution substation	19-12-2018	19-12-2018
3. Service area with n primary feeders	24-12-2018	24-12-2018
4. Benefits derived through optimal location of substations.	31-12-2018	31-12-2018
5. Voltage drop and power-loss calculations	02-01-2019	02-01-2019
6. Derivation for voltage drop and power loss in lines	07-01-2019	07-01-2019
7. Manual methods of solution for radial networks	08-01-2019	08-01-2019
8. Three phase balanced primary lines.	09-01-2019	09-01-2019
9. Three phase balanced primary line.	21-01-2019	21-01-2019

Review Questions

Sl.No. - Questions	TLOs	BL
1. NULL 1.Analyze theService area with n primary feeders\n2.A 1-phase feeder circuit has total impedance of (0.5+j 0.2) ohms, Vr = 230V and, Ir = 5300 A, determine i) P.F of load ii) Load P.F for which impedance angle is Maximum iii) Derive the expression for load P.F for which the voltage drop is maximum.	TLO5	L1

Course Code and Title: **EE134 / Electrical Distribution Systems**	
Chapter Number and Title: **4 - Protection and Coordination**	Planned Hours: **8.00 hrs**

Learning Outcomes:-

At the end of the topic the student should be able to:

	Topic Learning Outcomes	COs	BL
1	Discuss the objectives of distribution system protection	CO5	L2
2	List out some of the common faults.	CO5	L1
3	Explain about different types of Protective devices	CO4	L6
4	Explain the Coordination of Protective Devices	CO5	L6

Lesson Schedule

Lecture No. - Portion covered per hour	Planned Delivery Date	Actual Delivery Date
1. Objectives of distribution system protection,	22-01-2019	22-01-2019
2. types of common faults and procedure for fault calculations.	23-01-2019	23-01-2019
4. Principle of operation of Fuses,	28-01-2019	28-01-2019
5. Circuit reclosures	29-01-2019	29-01-2019
6. line sectionalizes,	30-01-2019	30-01-2019
7. circuit breakers.	04-02-2019	04-02-2019
8. Coordination of Protective Devices	05-02-2019	05-02-2019
9. General coordination procedure.	06-02-2019	06-02-2019

Review Questions

Sl.No. - Questions	TLOs	BL
1. NULL 1.Explain the necessity of coordination and various types of coordination in distribution systems.\n2.Discuss different types of faults and their calculations	TLO1	L2

Course Code and Title: **EE134 / Electrical Distribution Systems**	
Chapter Number and Title: **5 - Compensation for Power Factor Improvement and Voltage Control**	Planned Hours: **12.00 hrs**

Learning Outcomes:-

At the end of the topic the student should be able to:

	Topic Learning Outcomes	COs	BL
1	Explain Capacitive compensation for power-factor control	CO6	L6
2	Discuss the differences between shunt and series capacitors	CO6	L2
3	Explain the calculation of PF correction	CO6	L6
4	Summarize the Procedure to determine the best capacitor location	CO6	L6
5	Explain different methods of Voltage control	CO7	L6
6	Explain the effect of shunt and series capacitors on voltage control.	CO7	L6

Lesson Schedule

Lecture No. - Portion covered per hour	Planned Delivery Date	Actual Delivery Date
1. Capacitive compensation for power-factor control.	11-02-2019	11-02-2019
2. Different types of power capacitors	12-02-2019	12-02-2019
3. shunt and series capacitors,	13-02-2019	13-02-2019
4. effect of shunt capacitors	18-02-2019	18-02-2019
5. Power factor correction,	19-02-2019	19-02-2019
6. capacitor allocation - Economic justification	20-02-2019	20-02-2019
7. Procedure to determine the best capacitor location	25-02-2019	25-02-2019
8. voltage Control	27-02-2019	27-02-2019
9. Equipment for voltage control	05-03-2019	05-03-2019
10. effect of series capacitors,	06-03-2019	06-03-2019
11. effect of AVB/AVR	11-03-2019	11-03-2019
12. line drop compensation	12-03-2019	12-03-2019
13. line drop compensations	13-03-2019	13-03-2019

Review Questions

Sl.No. - Questions	TLOs	BL
1. NULL 1Explain the procedure to determine the best capacitor location in distribution system.\n 2.Explain about the voltage control methods and write one method with neat sketch.	TLO6	L6

Question Paper Title: External Q.Paper IV EEE		
Total Duration (H:M): 3hrs	**Course: Electrical Distribution Systems (EE134)**	**Maximum Marks: 70**
Note: Answer all questions in Part-A and any 5 questions in Part-B		

A				
Q.No.	**Questions**	**Marks**	**CO**	**BL**
1	What is loss factor? How is it related to load factor?	2.00	CO1,	
2	Classify different types of distribution loads.	2.00	CO1,	
3	Discuss the benefits, which are derived through optimal location of substations.	2.00	CO2,	
4	What is meant by primary feeder loading?	2.00	CO2,	
5	Define nominal voltage and rated voltage.	2.00	CO1,	
6	What do you mean by secondary distribution system?	2.00	CO2,	
7	What are the objectives of Distribution system protection?	2.00	CO4,	
8	What are the main differences between the fuse and the circuit breaker in the protection of distribution system?	2.00	CO4,	
9	Justify the need of capacitor effect in the voltage control in the distribution system.	2.00	CO5,	
10	Explain the four disadvantages of poor power factor?	2.00	CO5,	

B				
Q.No.	**Questions**	**Marks**	**CO**	**BL**
11	a) Draw a schematic single line diagram of an electrical distribution system and explain its typical parts in detail. \n b) A primary feeder is supplying power to a variable load. Every day and all year long, the load has a daily constant peak value of 50 MW between 7 pm until 7 am and a daily constant off-peak value of 5 MW between 7 am until 7 pm. \n	10.00	CO1,	

	Calculate the i) Load factor of the feeder ii) Loss factor of the feeder.			
12	a) Discuss the factors to be considered while designing the loop type distribution feeder. \n b) Compare 4 and 6 primary feeder system.	10.00	CO2,	
13	a) Explain the classification of substations according to design. \n b) What are the advantages and disadvantages of outdoor substation as compared to indoor substation?	10.00	CO2,	
14	Derive the voltage drop and power loss expressions of a feeder with a uniformly distributed load.	10.00	CO3,	
15	a) Explain Recloser to Circuit breaker coordination procedure in distribution system protection. \n b) What is the need for coordination? List the various coordination of protective devices. \n	10.00	CO4,	
16	a) A 5 mile long feeder is supplying a 2000 KVA load of increasing load density starting at a substation. If the 'K' constant of the feeder is given as 0.00001%VD per KVA-Mile. Determine the percentage voltage drop in the main. \n b) Derive the expression for substation service area with 'N' primary feeders.	10.00	CO3,	
17	a) If a power system has 15000 KVA capacity and is operating at a power factor of 0.65 lagging and the cost of synchronous capacitor is Rs 900/KVA. Find the investment required to correct the power factor to 0.85 lagging. \n b) Explain the effect of fixed and switched capacitor banks \n eders.	10.00	CO5,	
18	a) Explain the advantages of shunt and series capacitors. \n b) Discuss in brief, the general coordination procedure.	10.00	CO4,CO5,	