



## FACULTY OF ENGINEERING & TECHNOLOGY

### First Year Master of Technology

#### Semester I

**Course Code:** 102450104

**Course Title:** DISTRIBUTED GENERATION AND MICROGRIDS

**Type of Course:** Program Elective I

**Course Objectives:** To provide a insight into grid systems and micro grids.

#### Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
Lecture	Tutorial	Practical		Internal		External		Total
				Theory	J/V/P*	Theory	J/V/P*	
3	0	2	4	30/15	20/10	70/35	30/15	150/75

\* J: Jury; V: Viva; P: Practical

#### Detailed Syllabus:

Sr.	Contents	Hours
1	DISTRIBUTED GENERATION: Energy Sources and their availability -trends in energy consumption, conventional and non-conventional energy sources – review of solar photovoltaic – wind energy systems – fuel cells, energy storage systems: batteries – ultra capacitors – fly wheels – captive power plants. Distributed generation – concept and topologies, renewable energy in distributed generation. IEEE 1547 Standard for interconnecting distributed generation to electric power systems – DG installations – siting and sizing of DGs – optimal placement – regulatory issues	9
2	ISSUES IN GRID INTEGRATION OF DISTRIBUTED ENERGY RESOURCES: Basic requirements of grid interconnections – operational parameters – voltage, frequency and THD limits – grid interfaces – inverter based DGs and rotary machines based DGs – reliability, stability and power quality issues on grid integration – impact of DGs on protective relaying and islanding issues in existing distribution grid.	10
3	MICROGRIDS: Introduction to microgrids – types – structure and configuration of microgrids – AC and DC microgrids – power electronic interfaces for microgrids – energy management and protection control strategies of a microgrid - case studies.	10



<b>4</b>	<b>CONTROL AND OPERATION OF MICROGRID:</b> Modes of operation and control of microgrid: grid connected and islanded mode, active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques, microgrid communication infrastructure, power quality issues in microgrids, regulatory standards, microgrid economics, and introduction to smart microgrids.	<b>10</b>
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### Suggested Specification table with Marks (Theory) (Revised Bloom’s Taxonomy):

Distribution of Theory Marks						R: Remembering; U: Understanding; A: Application, N: Analyze; E: Evaluate; C: Create
R	U	A	N	E	C	
20	25	20	15	10	10	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

### Reference Books:

<b>1</b>	Essentials of Distributed Generation Systems, Gregory W. Massey, Jones & Bartlett Publishers.
<b>2</b>	Integration of Distributed Generation in the Power System Math H. Bollen, John Wiley & Sons.
<b>3</b>	Distributed Generation, N. Jenkins, Nicholas Jenkins, IET Press.
<b>4</b>	Microgrids and Active Distribution Networks, S. Chowdhury, P. Crossley, IET Press.
<b>5</b>	Design of Smart Power Grid Renewable Energy Systems, Ali Keyhani, John Wiley & Sons.

### Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
<b>CO-1</b>	Understand the grid system.	<b>30 %</b>
<b>CO-2</b>	Students able to know the issues in grid integration of distributed energy resources.	<b>30 %</b>
<b>CO-3</b>	Understand the control and operation of micro grids.	<b>25 %</b>
<b>CO-4</b>	Economic analysis for microgrid operational modes with control system	<b>15 %</b>

### List of Practicals / Tutorials:

<b>1</b>	Case study on “Energy Sources and their availability -trends in energy consumption”.
<b>2</b>	Review of solar photovoltaic – wind energy systems – fuel cells, energy storage systems.
<b>3</b>	To study about basic requirements of grid interconnections.
<b>4</b>	To study about various issues of distributed generation and their Technical impacts on the distribution system.
<b>5</b>	To study various protection issues with distributed generations.
<b>6</b>	To study about impact of Distributed Generations (DGs) on protective relaying and islanding issues in existing distribution grid.
<b>7</b>	Study on Standards for interconnecting distributed generation to electric power systems.
<b>8</b>	Case study on “Integrating Electric Vehicles to the Grid”.
<b>9</b>	Case study on “Energy management and protection control strategies of a microgrid”
<b>10</b>	Case study on “Microgrid economics”.

### Supplementary learning Material:



**CVM**  
**UNIVERSITY**

(Established under Gujarat Private Universities  
(Second Amendment) Act : 2019 Gujarat Act No. 20 of 2019)

<b>Curriculum Revision:</b>	
Version:	<b>1</b>
Drafted on (Month-Year):	Apr-20
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