Academic Course Description

BHARATH UNIVERSITY
Faculty of Engineering and Technology
Department of Electrical and Electronics Engineering
BEE019 SMART GRID

Seventh Semester (Odd Semester)

Course (catalog) description

To enable the students acquire knowledge on smart grid, different options of architectural design and communication technology for various aspects of smart grid , System analysis and stability analysis in smart grid, renewable energy sources and storage integration with smart grid.

Compulsory/Elective course   **:**   Elective for EEE students

Credit & Contact hours   :   3 and 45 hours

Course Coordinator   :   Dr.V.Jayalakshmi

Instructors   **:**   Mr. S. Dinakar Raj

Name of the instructor	Class handling	Office location	Office phone	Email (domain:@ bharathuniv.ac.in	Consultation
Mr.s. Dinakar Raj	Final year EEE	KS 304	04422290125	Jayalakshmi.eee@ bharathuniv.ac.in	12:30pm-1:30pm

Relationship to other courses:

Pre –requisites   **:** BEE505 & POWER GENERATION SYSTEMS

Assumed knowledge : Basic knowledge in power system and Facts Devices

Syllabus Contents

UNIT I   INTRODUCTION TO SMART GRID   9
Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Concept of Resilient &Self Healing Grid, Present development & International policies in Smart Grid, Diverse perspectives from experts and global Smart Grid initiatives.

UNIT II   SMART GRID TECHNOLOGIES   9
Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/VAr control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV).

UNIT III   SMART METERS   9
Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU), Intelligent Electronic Devices(IED) & their application for monitoring & protection.

UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID   9
Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

UNIT V HIGH PERFORMANCE COMPUTING   9
Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN),Broadband over Power line (BPL), IP based Protocols, Basics of Web Service and CLOUD Computing to make Smart Grids smarter, Cyber Security for Smart Grid.

Text book(s) and/or required materials

T1.   Vehbi C. Güngör, Dilan Sahin, Taskin Kocak, Salih Ergüt, Concettina Buccella, Carlo Cecati, and Gerhard P. Hancke, Smart
    Grid Technologies Communication Technologies and Standards IEEE Transactions On Industrial Informatics, Vol. 7, No. 4,
        November 2011

Reference Books:

R1.   Xi Fang, Satyajayant Misra, Guoliang Xue, and Dejun Yang "Smart Grid – The New and Improved Power Grid: A
            Survey" , IEEE Transaction on Smart Grids, 2011.
R2   Stuart Borlase "Smart Grid :Infrastructure, Technology and Solutions", CRC Press 2012.
 R3
https://www.youtube.com/watch?v=JwRTpWZReJk&list=PLzcxA4YJjE1s6NOlhCA34vrsFCeokjs9_
R4   https://iit.edu/news/iittoday/?tag=smart-grid

Computer usage: Matlab/Simulink

Professional component

General	-	0%
Basic Sciences	-	0%
Engineering sciences & Technical arts	-	0%
Major Electives	-	100%
Professional subject	-	0%

Broad area : Electrical Machines | Electronics | **Power system** | Control & Instrumentation

Test Schedule

S. No.	Test	Tentative Date	Portions	Duration
1	Cycle Test-1	August 1st week	Session 1 to 14	2 Periods
2	Cycle Test-2	September 2nd week	Session 15 to 28	2 Periods

| 3 | Model Test | October 2nd week | Session 1 to 45 | 3 Hrs |
| 4 | University Examination | TBA | All sessions / Units | 3 Hrs. |

Mapping of Instructional Objectives with Program Outcome

To enable the students acquire knowledge on smart grid, different options of architectural design and communication technology for various aspects of smart grid , System analysis and stability analysis in smart grid, renewable energy sources and storage integration with smart grid.	Correlates to program outcome		
	H	**M**	**L**
1. To understand The concepts and design of Smart grid.	c,f	b,g,i,j,l	a,d,e,h,k
2. To understand the various communication and measurement technologies in smart grid.	b,d	a,c,f,g,i,j	e,h,k
3. To understand the analysis and stability of smart grid.	c	a,d,e,f,i,j,k,l	b,g,h
4. To learn the renewable energy resources and storages integrated with smart grid.	a,b,c,e,g,i,k,l	F,j	d,h
5. To familiarize the high performance computing for Smart Grid applications	a,b,g,i,k,l	c,d,e,f,j	h

 H: high correlation, M: medium correlation, L: low correlation

Draft Lecture Schedule

S.NO	Topics	Problem solving (Yes/No)	Text / Chapter
UNIT I	**INTRODUCTION TO SMART GRID**		
1.	Evolution of Electric Grid,Concept	No	T1
2.	Definitions and Need for Smart Grid	No	
3.	Smart grid drivers	No	
4.	functions ,opportunities, challenges and benefits	No	
5.	Difference between conventional & Smart Grid,	No	
6.	Concept of Resilient &Self Healing Grid	No	
7.	Present development & International policies in Smart Grid	No	
8.	Diverse perspectives from experts and global Smart Grid initiatives.	No	
9.	Diverse perspectives from experts and global Smart Grid initiatives.	No	
UNIT II	**SMART GRID TECHNOLOGIES**		
10.	Technology Drivers, Smart energy resources	No	T1
11.	Smart substations	No	
12.	Substation Automation	No	
13.	Feeder Automation	No	
14.	Transmission systems: EMS	No	
15.	FACTS and HVDC,	No	
16.	Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/VAr control, Fault Detection,	No	

17.	Isolation and service restoration,	No	
18.	Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV).	No	
UNIT III	**SMART METERS**		
19.	Introduction to Smart Meters	No	
20.	Advanced Metering infrastructure (AMI) drivers and benefits	No	
21.	AMI protocols,	No	
22.	standards and initiatives	No	
23.	AMI needs in the smart grid	No	
24.	AMI needs in the smart grid	No	
25.	Phasor Measurement Unit(PMU),	No	R1
26.	Intelligent Electronic Devices(IED) & their application for monitoring & protection	No	
27.	Intelligent Electronic Devices(IED) & their application for monitoring & protection	No	
UNIT IV	**POWER QUALITY MANAGEMENT IN SMART GRID**		
28.	Power Quality,	No	
29.	EMC in Smart Grid	No	
30.	Power Quality issues of Grid connected Renewable Energy Sources	No	
31.	Power Quality issues of Grid connected Renewable Energy Sources	No	
32.	Power Quality Conditioners for Smart Grid,	No	R2
33.	Web based Power Quality monitoring	No	
34.	Web based Power Quality monitoring	No	
35.	Power Quality Audit	No	
36.	Power Quality Audit	No	
UNIT V	**HIGH PERFORMANCE COMPUTING**		
37.	Local Area Network (LAN), House Area Network (HAN)	No	
38.	House Area Network (HAN)	No	
39.	Wide Area Network (WAN)	No	
40.	Broadband over Power line (BPL)	No	R4
41.	IP based Protocols, Basics of Web Service	No	
42.	IP based Protocols, Basics of Web Service	No	
43.	CLOUD Computing to make Smart Grids smarter	No	
44	CLOUD Computing to make Smart Grids smarter	No	
45	Cyber Security for Smart Grid.	No	

Teaching Strategies

The teaching in this course aims at establishing a good fundamental understanding of the areas covered using:

- Formal face-to-face lectures

- Tutorials, which allow for exercises in problem solving and allow time for students to resolve problems in understanding of lecture material.

- Laboratory sessions, which support the formal lecture material and also provide the student with practical construction, measurement and debugging skills.

- Small periodic quizzes, to enable you to assess your understanding of the concepts.

Evaluation Strategies

Cycle Test – I	-	5%
Cycle Test – II	-	5%
Model Test	-	10%
Assignment	-	5%
Attendance	-	5%
Final exam	-	70%

Prepared by :   Dr.V.Jayalakshmi   **Dated :**

Addendum

<u>ABET Outcomes expected of graduates of B.Tech / EEE / program by the time that they graduate:</u>

a) An ability to apply knowledge of mathematics, science, and engineering fundamentals.

b) An ability to identify, formulate, and solve engineering problems.

c) An ability to design a system, component, or process to meet the desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

d) An ability to design and conduct experiments, as well as to analyze and interpret data.

e) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

f) An ability to apply reasoning informed by the knowledge of contemporary issues.

g) An ability to broaden the education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.

h) An ability to understand professional and ethical responsibility and apply them in engineering practices.

i) An ability to function on multidisciplinary teams.

j) An ability to communicate effectively with the engineering community and with society at large.

k) An ability in understanding of the engineering and management principles and apply them in project and finance management as a leader and a member in a team.

l) An ability to recognize the need for,and an ability to engage in life-long learning.

<u>Program Educational Objectives</u>

PEO1: PREPARATION
Electrical Engineering Graduates are in position with the knowledge of Basic Sciences in general and Electrical Engineering in particular so as to impart the necessary skill to analyze and synthesize electrical circuits, algorithms and complex apparatus.

PEO2: CORE COMPETENCE
Electrical Engineering Graduates have competence to provide technical knowledge, skill and also to identify, comprehend and solve problems in industry, research and academics related to power, information and electronics hardware.

PEO3: PROFESSIONALISM
Electrical Engineering Graduates are successfully work in various Industrial and Government organizations, both at the National and International level, with professional competence and ethical administrative acumen so as to be able to handle critical situations and meet deadlines.

PEO4: SKILL
Electrical Engineering Graduates have better opportunity to become a future researchers/ scientists with good communication skills so that they may be both good team-members and leaders with innovative ideas for a sustainable development.

PEO5: ETHICS
Electrical Engineering Graduates are framed to improve their technical and intellectual capabilities through life-long learning process with ethical feeling so as to become good teachers, either in a class or to juniors in industry.

BEE019 SMART GRID

Course Teacher	Signature
Mr.s. Dinakar Raj	

Course Coordinator   **HOD/EEE**

(Dr.V.Jayalakshmi)   (   )