Indian Institute of Technology Kanpur

Proposal for a New Course

1. Course Number: **EE 66XXX** 602

2. Course Title: **Real Time Simulation of Electric Power System with Microgrid.**

3. Per Lecture: 3 (L), Tutorial: _(T), Laboratory: _(P), Additional Hours [0-2]: _ (A), Credits (3*L+2*T+P+A): **9**

   Duration of the Course: **Full Semester**

4. Proposing Department/IDP: **Electrical Engineering Department**
   Other Department/IDPs which may be interested in the proposed course: **Department of Sustainable Energy Engineering.**
   Other faculty members interested in teaching the proposed course: **NA**

5. Proposing Instructor (S): **Dr Gururaj Mirle Vishwanath**
   Level of the Course: **PG**

6. Course Description:

   A. Background:
   The Conventional Distribution System in which the power flow was unidirectional, is in transformation stage with the proliferation of the renewables at a higher rate be it roof top or community owned Distributed Energy Resources (DERs). Apart from this, another important transformation which is taking place is transformation of the conventional vehicles with the Electric Vehicles (EVs). Henceforth, it is very vital to understand the influence of the renewables and the EVs on the operation of the existing distribution system and impact on the distribution side faults on the functionality of the DERs. In adherence to the need of educating the next generation professional graduates to be trained to face these challenges in actual field, this course is designed in such a way that they learn the fundamentals, real time simulation and exposure to the hardware prototype which empower them to be industry fit.

   B. Key Topics:
   - Architecture of Modern Distribution System and Microgrid.
   - Introduction to Real Time Simulator (what is EMT simulation and the significance of real time simulation).
   - Introduction to the Hardware in the Loop (HIL) and Power Hardware in the Loop Experimentation (PHIL).
   - Modelling and Design of Transformer using RTDS.
   - Modelling and Design of the Distribution Networks (Standard and Practical) with RTDS.
   - Modelling of Renewable Energy Sources (Wind and Solar) with RTDS.
   - Introduction to Electric Vehicles and Modelling using RTDS.

- Modelling of Power Electronic Converters with RTDS platform.
- Introduction to Various Faults and their effect on Microgrid.
- Case Studies on the Impact of Renewables on the operation of the Distribution System.
- Case Studies on the Impact of distribution faults on the operation of renewables which are part of microgrid.
- Exposure to the HIL and PHIL hardware prototypes of renewables based microgrid connected to the Distribution System.

C. Objectives:

- To learn about the Real time software and modelling.
- To learn about the modelling of distribution systems and Microgrid with the renewables and Electric Vehicles.
- To learn about the hardware implementation of the distribution system interfaced renewable energy using HIL/PHIL Platform.

D. Contents:

Sl No	Broad Title	Topics	No of Lectures (hrs): 35
1.	Introduction of the course	○ Architecture of Distribution Systems. ○ Real Time Simulator Introduction	5
2a.	Modelling of Distribution Systems and Microgrid	○ Modelling of Transformers. ○ Modelling of Microgrid.	5

2b	Modelling of Renewable Energy Sources and Electric Vehicle.	○ Modelling of the Solar. ○ Modelling of the DFIG wind system. ○ Modelling of the Li-Ion based EV/	10
2c	○ Modelling of Power Electronic Converters.	○ Modelling and Control of the Boost Converter. ○ Modelling and Control of the Bidirectional Converter. ○ Modelling and Control of the Three Phase Inverter	5
2d	○ Modelling of Distribution Networks.	○ Modelling of the IEEE 33 bus Distribution System. ○ Modelling of the Renewable Interfaced distribution system along with the EV.	5
3.	Case Studies	○ Introduction to Various Faults and their effect on Distribution Systems. ○ Case Studies on the Impact of Renewables	5

		based microgrid on the operation of the Distribution System. o Case Studies on the Impact of distribution faults on the operation of renewables which are part of microgrid. o Exposure to the HIL and PHIL hardware prototype.	

E. Pre-requisites, if any: Basic Understanding about Microgrid

F. Short summary for including in the Courses of Study Booklet:

Distribution Systems, Transformers, Renewable Energy Sources, Real time case studies, Fault Analysis, Hardware in the loop studies.

7. Course Evaluation.

Type of Evaluation	Max Marks
Mid Sem	30
Project	25
End Sem	45

8. Recommended Textbooks:

1.Remus Teodorescu, Marco Liserre and Pedro Rodriguez – "Grid Converters for Photovoltaics and Wind Power Systems", Wiley Publications, 2011.
2. Hassan Bevrani, Bruno Francois and Toshifumi Ise - "Microgrid Dynamics and Control", Wiley Publications, 2017.
3.Janaka B Ekanayake, Nick Jenkins, Kithsiri M Liyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid Technology and Applications, Wiley Publications, 2012. 4.Nikita Gupta (Editor), Mahajan Sagar Bhaskar (Editor), Sanjeevikumar Padmanaban (Editor), Dhafer Almakhles (Editor), "DC Microgrids: Advances, Challenges, and Applications", Wiley Publications, 2022.
5.Baseem Khan (Editor), Sanjeevikumar Padmanaban (Editor), Hassan Haes Alhelou (Editor), Om Prakash Mahela (Editor), S. Rajkumar (Editor), "Artificial Intelligence-Based Energy Management Systems for Smart Microgrids", CRC Press Taylor and Francis Group, 2022.