DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI

COURSE OUTLINE TEMPLATE			
Course Title	**ELECTRICAL SYSTEMS IN WIND ENERGY**		
Course Code	**EE631**	**No. of Credits**	**03**
Department	**EEE**	**Faculty**	**N. Kumaresan**
Pre-requisites Course Code	**Electrical machines and power electronics**		
Course Coordinator(s) (if, applicable)	**---**		
Other Course Teacher(s)/Tutor(s) E-mail	**---**	**Telephone No.**	**0431-2503257**
Course Type	☐ **Core course**	☑ **Elective course**	

COURSE OVERVIEW

In the last three decades there is an increasing emphasis on the exploitation of renewable energy resources. Among these sources, Wind Energy Electric Conversion Systems (WEECs) have been found to be viable in contributing significant amount of electric power, when installed in locations where adequate wind potential is available over most part of the year. Multi megawatt wind-turbine generators feeding power to the grid have become a commercial reality in large wind farms.

In WEECs, Induction machines functioning as generators, either directly supplying power to the grid or operating in the self-excited mode with terminal capacitors for stand alone applications, have become popular, in view of their advantages over other types of generators. Permanent Magnet Synchronous Generators are also incresingly employed with wind energy.

Now-a-days, with the development of power electronic converters, the variable speed wind turbine generator systems are extensively employed for capturing maximum possible energy from the wind.

So, this course aims to give the exposure to the students on the analysis and operational aspects of typical electrical generators and associated power electronic controllers employed in WEECs. To have the hands-on experience with such systems, Laboratory exercise and group / team task are planned as part of this course.

COURSE OBJECTIVES

- To introduce the various electrical generators and appropriate power electronic controllers employed in wind energy systems.
- To teach the students the steady-state analysis and operation of different existing configurations of electrical systems in wind energy and also the recent developments taking place in this field.

COURSE OUTCOMES (CO)	
Course Outcomes	**Aligned Programme Outcomes (PO)**
Upon completion of the course, the students will be able to	
1. Explain the principles of operation of electrical generators used in wind energy systems.	1, 2, 5, 6, 7, 8, 10, 11, 12, 13, 14
2. Carry out the steady-state analysis and predetermine performance of the electrical systems in wind energy.	1, 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
3. Design and implement the suitable closed-loop power electronic controller for specific applications.	1, 2, 5, 6, 7, 8, 10, 11, 12, 13, 14

COURSE TEACHING AND LEARNING ACTIVITIES			
S.No.	**Week**	**Topic**	**Mode of Delivery**
1	1st week of January 16 (4 to 8) **(2 Contact Hours)**	Introduction to the course Course plan – evaluation methods etc.	Lecture PPT or any suitable mode
2	2nd week of January 16 (11 to 15) **(2 Contact Hours)**	Wind basics – power in the wind, power curve, power coefficients, tip-speed ratio, etc. Review of operation of various electrical generators	
3	3rd week of January 16 (18 to 22) **(3 Contact Hours)**	Steady-state analysis and characteristics of GCIGs Experimental procedure for connecting GCIG to grid Operation of GCIGs & PMSGs with different power electronic configurations	Lecture / Tutorial C & T / PPT or any suitable mode
4	4th week of January 16 (25 to 29) **(2 Contact Hours)**	Experimentation on 3-phase GCIG **(Assessment - 3)**	Laboratory exercise
5	1st week of February 16 (1 to 5) **(3 Contact Hours)**	Process of self-excitation - SEIG Steady-state analysis & performance equations	Lecture / Tutorial C & T / PPT or any suitable mode
6	2nd week of February16 (8 to 12) **(2 Contact Hours)**	widening the operating speed-range of SEIGs by changing the stator winding connection with suitable solid state switching schemes **ASSESSMENT - 1**	Lecture C & T / PPT or any suitable mode **Quiz**

S.No.	Week	Topic	Mode of Delivery
7	3rd week of February16 (15 to 19) **(2 Contact Hours)**	Experimentation on 3-phase SEIG **(Assessment - 3)**	Laboratory exercise
8	4th week of February16 (22 to 26) **(4 Contact Hours)**	Power electronic controllers used in SEIG / PMSG for supplying isolated loads Need for single-phase operation – typical configurations for the single-phase operation of 3-phase GCIGs – steady-state anayysis	Lecture / Tutorial C & T / PPT or any suitable mode
9	1st week of March 16 (29 Feb to 3 March) **(3 Contact Hours)**	Typical configurations for the single-phase operation of 3-phase SEIGs – steady-state anayysis	Lecture / Tutorial C & T / PPT or any suitable mode
10	2nd week of March 16 (7 to 11) **(3 Contact Hours)**	**ASSESSMENT – 2** Experimentation on the 1-phase operation of 3-phase GCIG & SEIG **(Assessment - 3)**	**Mid-semester examination** Laboratory exercise
11	3rd week of March 16 (14 to 18) **(3 Contact Hours)**	DFIG – Different operating modes – steady-state equivalent circuit and analysis DFIG for stand-alone applications	Lecture / Tutorial C & T / PPT or any suitable mode
12	5th week of March 16 (28 March to 1 April) **(3 Contact Hours)**	Demonstration of operation of DFIG, Permanent Magnet Alternator and 5 kVA wind-turbine system. **(Assessment - 3)**	Laboratory exercise
13	2nd week of April 16 (4 to 8) **(3 Contact Hours)**	Operation of DFIGs with different power electronic configurations for standalone and grid-connected operation.	Lecture / Tutorial C & T / PPT or any suitable mode
14	3rd week of April 16 (11 to 15) **(3 Contact Hours)**	Operation of PMSGs- steady-state analysis- performance characteristics	Lecture / Tutorial C & T / PPT or any suitable mode
15	4th week of April 16 (18 to 22) **(3 Contact Hours)**	**ASSESSMENT – 4** **CPA**	**Group / Team task** **Written test**
17	April / May 16 Date of examination will be intimated later	**ASSESSMENT – 5** **End semester examination**	**Written Exam** (Descriptive Type)

C & T : Chalk and Talk and PPT : Power Point

COURSE ASSESSMENT METHODS

S.No.	Mode of Assessment	Week/Date	Duration	% Weightage
1	Quiz (First 1 ½ Units)	2nd Week of February 2016	30 Minutes	10
2	Mid Semester Examination (Written test) (First 3 Units)	2nd week of March 2016	90 Minutes	25
3	Laboratory exercise	During the conduct of lab	Please see the course plan	10
4	Group / Team Task	4th week of April 2016	Work will be carried out along with the course	15
CPA	Compensation Assessment (Written Test)	4th week of April 2016	90 Minutes	Please refer course policy for more details
5	End Semester Examination (Written test)	Last week of April / 1st week of May 2016	120 Minutes	40

Note:

1. **Attending all the assessments (Assessment 1 to 5) are MANDATORY for every student.**
2. **If any student is not able to attend Assessment-1 / Assessment-2 due to genuine reason, student is permitted to attend the compensation assessment (CPA) with 25 % weightage (25 marks). For the students who have missed Assessment-1 (quiz) of 10 % weightage then CPA mark will be converted to 10 % weightage (i.e., for 10 marks).**
3. **At any case, CPA will not be considered as an improvement test.**
4. **Every student is expected to score minimum 40% (i.e., 40 marks) to pass the course. Otherwise the student would be declared fail and 'F' grade will be awarded.**

ESSENTIAL READINGS : Textbooks, reference books Website addresses, journals, etc

1. Research publications from IEEE / IET / Elsevier journals – will be intimated during the class work.
2. Marcelo Godoy Simões and Felix A. Farret, 'Renewable Energy Systems: Design and Analysis with Induction Generators', CRC Press, ISBN 0849320313, 2004.
3. Ion Boldea, 'Variable speed Generators', CRC Press, ISBN 0849357152, 2006.
4. Lecture materials by the course teacher.

COURSE EXIT SURVEY (mention the ways in which the feedback about the course is assessed and indicate the attainment also)

Feedback from the students during class committee meetings
Anonymous feedback through questionnaire

COURSE POLICY (including plagiarism, academic honesty, attendance, etc.)

CORRESPONDENCE

1. All the students are advised to check their NITT WEBMAIL regularly. All the correspondence (schedule of classes/ schedule of assessment/ course material/ any other information regarding this course) will be done through their webmail.
2. Queries (if required) may be emailed to me / contact me during 4.00 pm to 5.00 pm on Monday and Friday with prior intimation for any clarifications.

ATTENDANCE

1. Attendance will be taken by the faculty in all the contact hours. Every student should maintain minimum 75 % physical attendance in these contact hours to attend the end semester examination.

2. Any student, who fails to maintain 75% attendance need to appear for the compensation assessemnt (CPA). Student who scores more than 60 % marks in the CPA will be eligible for attending the end semester examination.

3. Students not having 75% minimum attendance at the end of the semester and also fail in CPA (scoring less than 60%) will have to RE DO the course.

ACADEMIC HONESTY & PLAGIARISM

1. All the students are expected to be genuine during the course work. Taking of information by means of copying simulations, assignments, looking or attempting to look at another student's paper or bringing and using study material in any form for copying during any assessments is considered dishonest.
2. Tendering of information such as giving one's program, simulation work, assignments to another student to use or copy is also considered dishonest.
3. Preventing or hampering other students from pursuing their academic activities is also considered as academic dishonesty.
4. Any evidence of such academic dishonesty will result in the loss of marks on that assessment. Additionally, the names of those students so penalized will be reported to the class committee chairperson and HoD for necessary action.
5. Students who honestly producing ORIGINAL and OUTSTANDING WORK will be REWARDED.

ADDITIONAL COURSE INFORMATION

FOR APPROVAL

Course Faculty _____ CC-Chairperson _____ HOD _____