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)	**---**		
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 17 (4 to 6) **(2 Contact Hours)**	Introduction to the course Course plan – evaluation methods Introduction to Wind energy electric conversion systems	Lecture PPT or any suitable mode
2.	2nd week of January 17 (09 to 13) **(3 Contact Hours)**	Power in the wind, power curve, power coefficients, tip-speed ratio, etc. Review of operation of various electrical generators	
3.	3rd week of January 17 (16 to 20) **(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	
4.	4th week of January 17 (23 to 27) **(3 Contact Hours)**	Experimentation on 3-phase GCIG **(Assessment - 3)**	Laboratory exercise
5.	Last week of January & 1st week of February 17 (30-31 Jan & 1 to 3 Feb) **(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 February17 (6 to 10) **(3 Contact Hours)**	Steady-state analysis of SEIG (contd..) widening the operating speed-range of SEIGs by changing the stator winding connection with suitable solid state switching schemes	
7.	3rd week of February17 (13 to 17) **(3 Contact Hours)**	Experimentation on 3-phase SEIG **(Assessment - 3)**	Laboratory exercise

S.No.	Week	Topic	Mode of Delivery
8.	4th week of February17 (20 to 24) **(3 Contact Hours)**	Power electronic controllers used in SEIG / PMSG for supplying isolated loads **(Assessment - 1)** **Written test**	Lecture / Tutorial C & T / PPT or any suitable mode
9.	Last week of February - 1st week of March 17 (27 Feb to 3 March) **(1 Contact Hour)**	Need for single-phase operation – typical configurations for the single-phase operation of 3-phase GCIGs	
10.	2nd week of March 17 (6 to 10) **(3 Contact Hours)**	Steady-state analysis of single-phase operation of 3-phase GCIGs Typical configurations for the single-phase operation of 3-phase SEIGs – steady-state analysis	
11.	3rd week of March 17 (13 to 17) **(3 Contact Hours)**	Steady-state analysis of single-phase operation of 3-phase SEIGs DFIG – Different operating modes – steady-state equivalent circuit and analysis	
12.	4th week of March 17 (20 to 24) **(3 Contact Hours)**	DFIG for stand-alone applications Experimentation on the 1-phase operation of 3-phase GCIG **(Assessment - 3)**	Laboratory exercise
13.	5th week of March 17 (27 to 31) **(3 Contact Hours)**	Operation of DFIGs with different power electronic configurations for standalone and grid-connected operation. **(Assessment - 2)** **Written test**	
14.	1st week of April 17 (3 to 7) **(3 Contact Hours)**	Experimentation on the 1-phase operation of 3-phase SEIG **(Assessment - 3)** Demonstration of operation of DFIG, Permanent Magnet Alternator and 5 kVA wind-turbine system. **(Assessment - 3)**	Laboratory exercise
15.	2nd week of April 17 (10 to 14) **(3 Contact Hours)**	Operation of PMSGs- steady-state analysis- performance characteristics **(Assessment - 3)** Seminar presentation	Lecture / Tutorial C & T / PPT or any suitable mode
16.	3rd week of April 17 (17 to 21) **(3 Contact Hours)**	**(Assessment - 3)** Seminar presentation **CPA**	**PPT** **Written test**

S.No.	Week	Topic	Mode of Delivery
17.	April / May 17 Date of examination will be intimated later	**ASSESSMENT-4** **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	Assessment-1 (First 2 Units) **(Written test)**	4th week of February 17 (20 to 24)	60 Minutes	20
2	Assessment-2 (3rd and 4th Units) **(Written test)**	5th week of March 17 (27 to 31)	60 Minutes	20
3	Assessment-3 (i) Laboratory exercise-10%, (ii) Seminar presentation-5% and (iii) Computer programing / simulation / Report preparation-5%	During the regular class hours / details will be informed later		20
CPA	Compensation Assessment (First 4 Units) **(Written test)**	2nd week of April 17 (10 to 14)	60 Minutes	20
5	Assessment-4 (All units) **(Written test)**	3rd / 4th week of April 17	120 Minutes	40

Note:

1. Exact date and time for the assessments (1,2 & 4) will be informed later.
2. Attending all the assessments (i.e., Assessment 1 to 4) are MANDATORY for every student.
3. If any student is not able to attend Assessment-1 / Assessment-2 due to genuine reason, he/she is permitted to attend the Compensation Assessment (CPA) with 20% weightage (20 marks).
4. At any case, CPA will not be considered as an improvement test.

Grading the students

1. Grading will be based on the clusters (range) of the total marks (all the assessments i.e., Assessment 1 to 4, put together for each student) scored. For grading, Gap theory or Normalized curve method will be used to decide the clusters (range) of the total marks.
2. The passing minimum shall be class mean by two or maximum by three, whichever is lower. Hence, every student is expected to score the minimum mark 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 10.30 am to 11.30 am on Monday and Wednesday 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 Assessment-4 i.e., last assessment.

2. Any student, who fails to maintain 75% attendance, however, having score more than 50 % marks (i.e., more than 30 marks) in first three assessments will be eligible for attending the last assessment (Assessment-4).

3. Students having less than 75% attendance at the end of the semester and also having the score less than 50 % marks (i.e., less than 30 marks) in first three assessments will have to REDO the course and hence they are not eligible for attending the last assessment (Assessment-4). 'V' Grade will be awarded for such students.

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 2/1/17 CC-Chairperson 03.01.17 HOD