# 36. Course Specification of Electrical machines 2

| I. Course Identification and General Information: | | | | | | | |
|---|---|---|---|---|---|---|---|
| **1.** | Course Title: | Electrical Machines 2 | | | | | |
| **2.** | Course Code & Number: | PME224 | | | | | |
| **3.** | Credit hours: | C.H | | | | Total | |
| | | Th. | Tu. | Pr. | Tr. | | |
| | | 2 | 2 | 2 | | 4 | |
| **4.** | Study level/ semester at which this course is offered: | 3rd Level/2nd Semester | | | | | |
| **5.** | Pre –requisite (if any): | PME112, PME221 | | | | | |
| **6.** | Co –requisite (if any): | NA | | | | | |
| **8.** | Program (s) in which the course is offered: | Electrical Power and Machines Engineering | | | | | |
| **9.** | Language of teaching the course: | English | | | | | |
| **10.** | Location of teaching the course: | Sanaa university, Faculty of Engineering | | | | | |
| **11.** | Prepared By: | Asst. Prof. Dr. Amin Abdelghani H. Mahyob | | | | | |
| **12.** | Date of Approval | | | | | | |

## II. Course Description:

This course is designed to provide principal concepts of AC electrical machines. The course covers construction, classification, performance characteristics, analysis, parallel operation, testing and applications of: three-phase transformers, synchronous and induction machines . The course covers the generating and motoring modes of operations for both synchronous and induction machines .

| III. Course Intended learning outcomes (CILOs) of the course | | Referenced PILOs |
|---|---|---|
| **a1** | Identify the operation principles, construction, performance characteristics, application areas, merits and demerits of three phase transformers, synchronous and asynchronous machines. | A1,A3. |

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|---|---|---|
| **a2** | Express the equivalent circuit, the analytic model, parallel operation, regulation of three-phase transformers, synchronous and induction machines and give un introduction to the speed control of synchronous and induction motors. | A1, A3 |
| **b1** | Evaluate the operation conditions, modeling and design principles of AC three phase AC machines using mathematical models and computer simulation. | B1,B2,B3 |
| **b2** | Identify the various requirements and operation conditions of three phase AC machines from the related manufacturer data sheets, codes and standards. | B1,B2,B3 |
| **c1** | Apply methods of regulation and speed control to adjust and/or modify the performance and the output characteristic of general type of rotating electrical machines. | C1,C2, |
| **c2** | Obtain experimentally the parameters and load characteristics of three-phase transformers, synchronous and induction motors and generators under different loading conditions, and computing tools to modeling simulating the AC machines | C1,C2,C3,C4 |
| **d1** | Work in teams to conduct experiments, analyze results, and develop technically sound reports of outcomes. | D1,D3,D4 |
| **d2** | Develop transferable skills of problem solving and design. | D2,D3,D4, D5 |

| **(A) Alignment Course Intended Learning Outcomes of Knowledge and Understanding to Teaching Strategies and Assessment Strategies:** | | |
|---|---|---|
| Course Intended Learning Outcomes | Teaching strategies | Assessment Strategies |
| a1- Identify the operation principles, construction, performance characteristics, application areas, merits and demerits of three phase transformers, synchronous and asynchronous machines.. | ▪ Lectures,<br>▪ Interactive class discussion,<br>▪ Self-study. | ▪ Laboratory reports,<br>▪ Assignments,<br>▪ Quizzes,<br>▪ Written exams,<br>▪ Lab. Exams,<br>▪ Homework. |
| a2- Express the equivalent circuit, the analytic model, parallel operation, regulation of three-phase transformers, synchronous and induction machines and give un introduction to the speed control of synchronous and induction motors.. | ▪ Lectures,<br>▪ Interactive class discussion,<br>▪ Self-study | ▪ Laboratory reports,<br>▪ Assignments,<br>▪ Quizzes,<br>▪ Written exams,<br>▪ Lab. Exams,<br>▪ Homework. |

| **(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:** | | |
|---|---|---|
| Course Intended Learning Outcomes | Teaching strategies | Assessment Strategies |
| **b1-** Evaluate the operation conditions, modeling and design principles of AC three phase AC machines using mathematical models and computer simulation. | ▪ Lectures,<br>▪ Interactive class discussion,<br>▪ Self-study. | ▪ Laboratory reports,<br>▪ Assignments,<br>▪ Quizzes,<br>▪ Written exams,<br>▪ Lab. Exams,<br>▪ Homework. |
| **b2-** Identify the various requirements and operation conditions of three phase AC machines from the related manufacturer data sheets, codes and standards. | ▪ Lectures,<br>▪ Interactive class discussion,<br>▪ Self-study | ▪ Laboratory reports,<br>▪ Assignments,<br>▪ Quizzes,<br>▪ Written exams,<br>▪ Lab. Exams, |

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| | | ▪ Homework. |

| © Alignment Course Intended Learning Outcomes of Professional and Practical Skills to Teaching Strategies and Assessment Strategies: | | |
|---|---|---|
| Course Intended Learning Outcomes | Teaching strategies | Assessment Strategies |
| **c1-** Apply methods of regulation and speed control to adjust and/or modify the performance and the output characteristic of general type of rotating electrical machines. | ▪ Lectures,<br>▪ Interactive class discussion,<br>▪ Self-study. | ▪ Laboratory reports,<br>▪ Assignments,<br>▪ Quizzes,<br>▪ Written exams,<br>▪ Lab. Exams,<br>▪ Homework. |
| **c2-** Experimentally obtain the parameters and load characteristics of various AC motors and generators under different loading conditions. | ▪ Lectures,<br>▪ Interactive class discussion,<br>▪ Self-study | ▪ Laboratory reports,<br>▪ Assignments,<br>▪ Quizzes,<br>▪ Written exams,<br>▪ Lab. Exams,<br>▪ Homework. |

| (D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies: | | |
|---|---|---|
| Course Intended Learning Outcomes | Teaching strategies | Assessment Strategies |
| **d1-** Work in teams to conduct experiments, analyze results, and develop technically sound reports of outcomes. | ▪ Interactive class discussion,<br>▪ Self-study. | ▪ Laboratory reports,<br>▪ Assignments,<br>▪ Quizzes,<br>▪ Written exams,<br>▪ Lab. Exams,<br>▪ Homework. |
| **d2-** Develop transferable skills of problem solving and design. | ▪ Interactive class discussion,<br>▪ Self-study | ▪ Laboratory reports,<br>▪ Assignments,<br>▪ Quizzes,<br>▪ Written exams,<br>▪ Lab. Exams, |

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| | | ▪ Homework. |

## IV. Course Content:

### A – Theoretical Aspect:

| Order | Units/Topics List | Learning Outcomes | Sub Topics List | Number of Weeks | Contact hours |
|---|---|---|---|---|---|
| **1.** | Three phase transformers | a1, a2, b1, b2, c1, c2, d1, d2 | ▪ Construction, Operation principles and application areas.<br>▪ Types of connections and group number<br>▪ equivalent circuit and Performance.<br>▪ Special connections<br>▪ Parallel operation.<br>▪ Ratings | 3 | 6 |
| **2.** | Three-phase Synchronous generators. | a1, a2, b1, b2, c1, c2, d1, d2 | ▪ Construction, Operation principles and application areas<br>▪ equivalent circuit and Performance characteristics.<br>▪ Voltage and Power regulations.<br>▪ Parallel operation of synchronous generators.<br>▪ Mathematical modeling of salient pole rotor and round pole rotors machines and MATLAB representation.<br>▪ Ratings and capability diagram | 5 | 10 |
| **3.** | Three-phase Synchronous motors. | a1, a2, b1, b2, c1, c2, d1, d2 | ▪ Construction, equivalent circuits, Performance | 2 | 4 |

| | | | | | |
|---|---|---|---|---|---|
| | | | characteristics, and application areas.<br>▪ Mathematical modeling and MATLAB representation.<br>▪ Speed control. | | |
| **4.** | Three-phase induction motors. | a1, a2, b1, b2, c1, c2, d1, d2 | ▪ Construction, Operation principles and application areas.<br>▪ Performance characteristics and equivalent circuits.<br>▪ Speed control and starting methods<br>▪ Mathematical and MATLAB modeling. | 4 | 8 |
| **Number of Weeks /and Units Per Semester** | | | | **14** | **28** |

## B- Tutorials Aspect:

| Order | Tutorial Skills List | Nº of Weeks | C.H. | CILOs |
|---|---|---|---|---|
| **1.** | Three-phase transformers.<br>• Equivalent circuits<br>• Performance characteristics<br>• Phasor diagram<br>• Determining model parameters.<br>• Open delta-open delta connections<br>• T and Scott connections<br>• Parallel operation | **3** | **6** | a1,a2,b1,b2,c1,c2,d1,d2, |
| **2.** | Three-phase Synchronous generators.<br>• Equivalent circuits<br>• Performance characteristics<br>• Phasor diagram<br>• Power and torque<br>• Determining model parameters. | **2** | **4** | a1,a2,b1,b2,c1,c2,d1,d2, |

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| | • Effect of load changes | | | |
| **3.** | Three-phase Synchronous generators.<br>• Mathematical and MATLAB model.<br>• Voltage and Power regulations.<br>• Parallel operation of synchronous generators<br>• Ratings and capability diagram. | **3** | **6** | a1,a2,b1,b2,c1,c2,d1,d2, |
| **4.** | Three-phase Synchronous motors.<br>• Equivalent circuits<br>• Performance characteristics<br>• Effect of load changes<br>• Effect of field current changes<br>• Power factor correction<br>• Starting of motor | **2** | **4** | a1,a2,b1,b2,c1,c2,d1,d2, |
| **5.** | Three--phase Induction motors.<br>• Concept of rotor slip<br>• Equivalent circuits<br>• Power and torque | **2** | **4** | a1,a2,b1,b2,,c1,c2,d1,d2, |
| **6.** | Three phase Induction motors.<br>• Performance characteristics.<br>• Determining model parameters.<br>• Starting control methods.<br>• Speed control methods. | **2** | **4** | a1,a2,b1,b2,c1,c2,d1,d2, |
| **Number of Weeks /and Units Per Semester** | | **14** | **28** | |

## C - Practical Aspect:

| Order | Tasks/ Experiments | Number of Weeks | Contact hours | Learning Outcomes |
|---|---|---|---|---|
| **1.** | ▪ Safety regulations and requirements in electrical laboratories.<br>▪ Introduction to main laboratory devices and instrumentations.<br>▪ Introduction to main measurement devices.<br>▪ Reporting format. | 1 | 2 | a1,a2,b1,b2,c1,c2,d1,d2 |
| **2.** | ▪ Three-phase transformers.<br>▪ Open circuit test<br>▪ Short circuit test<br>▪ Polarity test<br>▪ Load characteristics | 3 | 6 | a1,a2,b1,b2,c1,c2,d1,d2 |
| **3.** | ▪ Synchronous generator characteristics:<br>1. Open circuit cc<br>2. Short circuit cc<br>3. Zero power factor cc<br>▪ External (load) characteristics of three phase synchronous generator<br>▪ Voltage regulation of three phase synchronous generator | 2 | 4 | a1,a2,b1,b2,c1,c2,d1,d2 |
| **4.** | ▪ Parallel operation and synchronism of synchronous generator.<br>▪ Computer modeling of parallel operation and synchronism. | 1 | 2 | a1,a2,b1,b2,c1,c2,d1,d2 |
| **5.** | ▪ V – curve of Synchronous motor<br>▪ Computer modeling of three-phase synchronous motors. | 2 | 4 | a1,a2,b1,b2,c1,c2,d1,d2 |

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| **6.** | ▪ Starting and reversing of Three-phase Induction motors<br>▪ Performance characteristics of Three-phase Induction motors (no load, locked rotor, DC test and load test)<br>▪ Measurement of torque – speed of Three-phase Induction motors<br>▪ Effect of rotor resistance for behavior of three phase induction motor<br>▪ Computer modeling of three-phase induction motors. | 4 | 8 | a1,a2,b1,b2,c1,c2,d1,d2 |
| **7.** | ▪ Laboratory exam | 1 | 2 | a1,a2,b1,b2,c1,c2 |
| **Number of Weeks /and Units Per Semester** | | **14** | **28** | |

## V. Teaching strategies of the course:

- Lectures.
- Interactive class discussion.
- Tutorial classes and exercises.
- Series of laboratory experiment.
- Self-study of computer aided design software like Modelica and/MATLABAB.-

## VI. Assignments:

| No | Assignments | Aligned CILOs(symbols) | Week Due | Mark |
|---|---|---|---|---|
| **1.** | Design and implementation of three phase transformer circuits using MATLAB tools | a1,a2,b1,b2,d2 | 3rd | 2 |
| **2.** | Design and implementation of Synchronous generator circuits using MATLAB tools | a1,a2,b1,b2,d2 | 6th | 2 |
| **3.** | Design and implementation of Synchronous motor circuits using MATLAB tools | a1,a2,b1,b2,c1 | 10th | 2 |
| **4.** | Design and implementation of three induction motor circuits using MATLAB tools | a1,a2,b1,b2,c1 | 12th | 2 |

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| | **Total** | | | **8** |

## VII. Schedule of Assessment Tasks for Students During the Semester:

| No. | Assessment Method | Week Due | Mark | Proportion of Final Assessment | Aligned Course Learning Outcomes |
|---|---|---|---|---|---|
| **1.** | Quizzes | $4^{th}$ ,$7^{th}$ ,$10^{th}$ , and $13^{th}$ | 10 | 5% | a1,a2,b1,b2 |
| **2.** | Assignments & Homework, Tasks & Presentation | Weekly | 10 | 5% | a1,a2,b1,b2,d2 |
| **3.** | Mid-Term exam | $8^{th}$ | 40 | 20% | a1,a2,b1,b2 |
| **4.** | Laboratory attendance and reports | Weekly | 20 | 10% | a1,a2,b1,b2,c1,c2,d2 |
| **5.** | Final exam practical | $15^{th}$ | 20 | 10% | a1,a2,b1,b2,c1,c2,d2 |
| **6.** | Final Exam theory | $16^{th}$ | 100 | 50% | a1,a2,b1,b2 |
| | **Total** | | **200** | **100%** | |

## VIII. Learning Resources:

- *Written in the following order: ( Author - Year of publication – Title – Edition – Place of publication – Publisher).*

**1- Required Textbook(s) ( maximum two ).**

1. Chapman s. j. (2005), Electric Machinery Fundamentals,4th Edition, McGraw-Hill.
2. Fitzgerald A. E. (2003), Electric Machinery, 6h Edition, McGraw-Hill

**2- Essential References.**

1. D.F. Warne (2000), Newnes Electrical Engineer's Handbook, 1st Edition, Biddles Ltd- wwv. biddlesxo. Uk.
2. Nasar S. A. (1998), Electric machines and electromechanics, 2nd Edition, Schaum's outlines series- McGraw-Hill.
3. Bandyopadhyay M.N, (2009), ELECTRICAL MACHINES: THEORY AND PRACTICE, 1st Edition, Prentice-hall Of India Pvt Ltd.
4. Bimbhra P.S.,(1995), Electric Machinery , 7th Edition Khanna Publishers
5. M G Say, "Alternating current machines",4th edition, Pitman publishing Ltd.

**3- Electronic Materials and Web Sites etc.**

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1. Modelica Association (2000). ModelicaTM - A Unified Object-Oriented Language for Physical Systems Modeling. Tutorial Version 1.4 (ModelicaTutorial14.pdf). Available from: https://modelica.org/documents/
2. MapleSim Video Tutorial: Modelica Video lectures available form: http://www.youtube.com/watch?v=reehU1dzeDc.
3. Simulink-Matlab tutorial for beginners Video lectures available form:
4. http://www.youtube.com/results?search_query=simulink+tutorial+for+beginners&oq=simulink&gs_l=youtube.1.9.0l10.337429.342148.0.351270.8.8.0.0.0.0.738.2481.3j3-2j2j0j1.8.0...0.0...1ac.1.11.youtube.iIK7kMX6hfo


## IX. Course Policies:

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|---|---|
| **1.** | **Class Attendance:** A student should attend not less than 75 % of total hours of the subject; otherwise he will not be able to take the exam and will be considered as exam failure. If the student is absent due to illness, he/she should bring an approved statement from university Clinic |
| **2.** | **Tardy:** For late in attending the class, the student will be initially notified. If he repeated lateness in attending class he will be considered as absent. |
| **3.** | **Exam Attendance/Punctuality:** A student should attend the exam on time. He is Permitted to attend an exam half one hour from exam beginning, after that he/she will not be permitted to take the exam and he/she will be considered as absent in exam- |
| **4.** | **Assignments & Projects:** The assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time- |
| **5.** | **Cheating:** For cheating in exam, a student will be considered as failure. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty- |
| **6.** | **Plagiarism:** Plagiarism is the attending of a student the exam of a course instead of another student. If the examination committee proved a plagiarism of a student, he will be disengaged from the Faculty. The final disengagement of the student from the Faculty should be confirmed from the Student Council Affair of the university. |
| **7.** | **Other policies:** |

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| | - Mobile phones are not allowed to use during a class lecture. It must be closed, otherwise the student will be asked to leave the lecture room<br>- Mobile phones are not allowed in class during the examination.<br>Lecture notes and assignments my given directly to students using soft or hard copy |

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| **Reviewed By** | **Vice Dean for Academic Affairs and Post Graduate Studies: Asst. Prof. Dr. Tarek A. Barakat**<br>**President of Quality Assurance Unit: Assoc. Prof. Dr. Mohammed Algorafi**<br>**Name of Reviewer from the Department: Asst. Prof. Dr. Adel Ahmed Al-Shakiri** |
| | **Deputy Rector for Academic Affairs Asst. Prof. Dr. Ibrahim AlMutaa**<br>**Assoc. Prof. Dr. Ahmed Mujahed**<br>**Asst. Prof. Dr. Munasar Alsubri** |

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# 35. Template for Course Plan (Syllabus) of Electrical machines 2

## I. Information about Faculty Member Responsible for the Course:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Name of Faculty Member** | Dr. Amin Abdelghani H. Mahyob | **Office Hours** | | | | | |
| **Location& Telephone No.** | 770249615 | **SAT** | **SUN** | **MON** | **TUE** | **WED** | **THU** |
| **E-mail** | amin.mahyob@gmail.com | | | | | | |

## II. Course Identification and General Information:

| | | | | | | |
|---|---|---|---|---|---|---|
| **1.** | Course Title: | Electrical Machines 2 | | | | |
| **2.** | Course Code & Number: | PME224 | | | | |
| **3.** | Credit hours: | C.H | | | | Total |
| | | Th. | Tu. | Pr. | Tr. | |
| | | 2 | 2 | 2 | - | 4 |
| **4.** | Study level/ semester at which this course is offered: | 3rd Level/2nd Semester | | | | |
| **5.** | Pre –requisite (if any): | PME112, PME221 | | | | |
| **6.** | Co –requisite (if any): | NA | | | | |
| **7.** | Program (s) in which the course is offered: | Electrical Power and Machines Engineering | | | | |
| **8.** | Language of teaching the course: | English | | | | |
| **9.** | System of Study: | Regular | | | | |
| **10.** | Mode of delivery: | Lecture | | | | |
| **11.** | Location of teaching the course: | Class + Lab | | | | |

## III. Course Description:

This course is designed to provide principal concepts of AC electrical machines. The course covers construction, classification, performance characteristics, analysis, parallel operation, testing and applications of: three-phase transformers, synchronous and induction machines . The course covers the generating and motoring modes of operations for both synchronous and induction machines .

## IV. Intended learning outcomes (ILOs) of the course:

- Brief summary of the knowledge or skill the course is intended to develop**:**

1. Identify the operation principles, construction, performance characteristics, application areas, merits and demerits of three phase transformers, synchronous and asynchronous machines.
2. Express the equivalent circuit, the analytic model, parallel operation, regulation of three-phase transformers, synchronous and induction machines and give un introduction to the speed control of synchronous and induction motors.
3. Evaluate the operation conditions, modeling and design principles of AC three phase AC machines using mathematical models and computer simulation.
4. Identify the various requirements and operation conditions of three phase AC machines from the related manufacturer data sheets, codes and standards.
5. Apply methods of regulation and speed control to adjust and/or modify the performance and the output characteristic of general type of rotating electrical machines.
6. Obtain experimentally the parameters and load characteristics of three-phase transformers, synchronous and induction motors and generators under different loading conditions, and computing tools to modeling simulating the AC machines
7. Work in teams to conduct experiments, analyze results, and develop technically sound reports of outcomes.
8. Develop transferable skills of problem solving and design.

## V. Course Content:

### A – Theoretical Aspect:

| Order | Units/Topics List | Sub Topics List | Number of Weeks | Contact hours |
|---|---|---|---|---|
| **1.** | Three phase transformers | ▪ Construction, Operation principles and application areas.<br>▪ Types of connections and group number<br>▪ equivalent circuit and Performance.<br>▪ Special connections<br>▪ Parallel operation.<br>▪ Ratings | 1st ,2nd ,3rd | 6 |
| **2.** | Three-phase Synchronous generators. | ▪ Construction, Operation principles and application areas<br>▪ equivalent circuit and Performance characteristics.<br>▪ Voltage and Power regulations.<br>▪ Parallel operation of synchronous generators.<br>▪ Mathematical modeling of salient pole rotor and round pole rotors machines and MATLAB representation.<br>▪ Ratings and capability diagram | 4th ,5th ,6th ,7th | 8 |
| **2.** | Mid-Term Exam | ▪ | 8th | 2 |
| **3.** | Three-phase Synchronous generators. | ▪ Construction, Operation principles and application areas<br>▪ equivalent circuit and Performance characteristics.<br>▪ Voltage and Power regulations.<br>▪ Parallel operation of synchronous generators.<br>▪ Mathematical modeling of salient pole rotor and round pole rotors | 9th | 2 |

| | | | | |
|---|---|---|---|---|
| | | machines and MATLAB representation.<br>▪ Ratings and capability diagram | | |
| **4.** | Three-phase Synchronous motors. | ▪ Construction, equivalent circuits, Performance characteristics, and application areas.<br>▪ Mathematical modeling and MATLAB representation.<br>▪ Speed control. | $10^{th}$ ,$11^{th}$ | 4 |
| **5.** | Three-phase induction motors. | ▪ Construction, Operation principles and application areas.<br>▪ Performance characteristics and equivalent circuits.<br>▪ Speed control and starting methods<br>▪ Mathematical and MATLAB modeling. | $12^{th}$ ,$13^{th}$ ,$14^{th}$ ,$15^{th}$ | 8 |
| **6.** | Final Exam | ▪ | $16^{th}$ | 2 |
| **Number of Weeks /and Units Per Semester** | | | **16** | **32** |

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## B- Tutorials Aspect:

| Order | Tutorial Skills List | Nº of Weeks | C.H. |
|---|---|---|---|
| **1.** | Three-phase transformers.<br>• Equivalent circuits<br>• Performance characteristics<br>• Phasor diagram<br>• Determining model parameters.<br>• Open delta-open delta connections<br>• T and Scott connections<br>• Parallel operation | $1^{st}$ ,$2^{nd}$ ,$3^{rd}$ | 6 |
| **2.** | Three-phase Synchronous generators.<br>• Equivalent circuits<br>• Performance characteristics<br>• Phasor diagram<br>• Power and torque<br>• Determining model parameters.<br>• Effect of load changes | $4^{th}$ ,$5^{th}$ | 4 |
| **3.** | Three-phase Synchronous generators.<br>• Mathematical and MATLAB model.<br>• Voltage and Power regulations.<br>• Parallel operation of synchronous generators<br>• Ratings and capability diagram. | $6^{th}$ ,$7^{th}$ ,$8^{th}$ | 6 |
| **4.** | Three-phase Synchronous motors.<br>• Equivalent circuits<br>• Performance characteristics<br>• Effect of load changes<br>• Effect of field current changes<br>• Power factor correction<br>• Starting of motor | $9^{th}$ ,$10^{th}$ | 4 |
| **5.** | Three--phase Induction motors.<br>• Concept of rotor slip<br>• Equivalent circuits<br>• Power and torque | $11^{th}$ ,$12^{th}$ | 4 |

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| **6.** | Three phase Induction motors.<br>• Performance characteristics.<br>• Determining model parameters.<br>• Starting control methods.<br>• Speed control methods. | $13^{th}$ ,$14^{th}$ | 4 |
| **Number of Weeks /and Units Per Semester** | | **14** | **28** |

## C - Practical Aspect:

| Order | Tasks/ Experiments | Number of Weeks | Contact hours |
|---|---|---|---|
| **1.** | ▪ Safety regulations and requirements in electrical laboratories.<br>▪ Introduction to main laboratory devices and instrumentations.<br>▪ Introduction to main measurement devices.<br>▪ Reporting format. | $1^{st}$ | 2 |
| **2.** | ▪ Three-phase transformers.<br>▪ Open circuit test<br>▪ Short circuit test<br>▪ Polarity test<br>▪ Load characteristics | $2^{nd}$ ,$3^{rd}$ ,$4^{th}$ | 6 |
| **3.** | ▪ Synchronous generator characteristics:<br>1. Open circuit cc<br>2. Short circuit cc<br>3. Zero power factor cc<br>▪ External (load) characteristics of three phase synchronous generator<br>▪ Voltage regulation of three phase synchronous generator | $5^{th}$ ,$6^{th}$ | 4 |
| **4.** | ▪ Parallel operation and synchronism of synchronous generator.<br>▪ Computer modeling of parallel operation and synchronism. | $7^{th}$ | 2 |
| **5.** | ▪ V – curve of Synchronous motor | $8^{th}$ ,$9^{th}$ | 4 |

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| | | | |
|---|---|---|---|
| | ▪ Computer modeling of three-phase synchronous motors. | | |
| **6.** | ▪ Starting and reversing of Three-phase Induction motors<br>▪ Performance characteristics of Three-phase Induction motors (no load, locked rotor, DC test and load test)<br>▪ Measurement of torque – speed of Three-phase Induction motors<br>▪ Effect of rotor resistance for behavior of three phase induction motor<br>▪ Computer modeling of three-phase induction motors. | $10^{th}$ ,$11^{th}$ ,$12^{th}$ ,$13^{th}$ | 8 |
| **7.** | ▪ Laboratory exam | $14^{th}$ | 2 |
| **Number of Weeks /and Units Per Semester** | | **14** | **28** |

## VI. Teaching strategies of the course:

- Lectures.
- Interactive class discussion.
- Tutorial classes and exercises.
- Series of laboratory experiment.
- Self-study of computer aided design software like Modelica and/MATLABAB.-

## VII. Assignments:

| No | Assignments | Aligned CILOs(symbols) | Week Due | Mark |
|---|---|---|---|---|
| 1. | Design and implementation of three phase transformer circuits using MATLAB tools | a1,a2,b1,b2,d2 | 3rd | 2 |
| 2. | Design and implementation of Synchronous generator circuits using MATLAB tools | a1,a2,b1,b2,d2 | 6th | 2 |
| 3. | Design and implementation of Synchronous motor circuits using MATLAB tools | a1,a2,b1,b2,c1 | 10th | 2 |
| 4. | Design and implementation of three induction motor circuits using MATLAB tools | a1,a2,b1,b2,c1 | 12th | 2 |
| | **Total** | | | **8** |

## VIII. Schedule of Assessment Tasks for Students During the Semester:

| No. | Assessment Method | Week Due | Mark | Proportion of Final Assessment |
|---|---|---|---|---|
| 1. | Quizzes | 4th ,7th ,10th , and 13th | 10 | 5% |
| 2. | Assignments & Homework, Tasks & Presentation | Weekly | 10 | 5% |
| 3. | Mid-Term exam | 8th | 40 | 20% |
| 4. | Laboratory attendance and reports | Weekly | 20 | 10% |
| 5. | Final exam practical | 15th | 20 | 10% |
| 6. | Final Exam theory | 16th | 100 | 50% |
| | **Total** | | **200** | **100%** |

## IX. Learning Resources:

- *Written in the following order: ( Author - Year of publication – Title – Edition – Place of publication – Publisher).*

**1- Required Textbook(s) ( maximum two ).**

1. Chapman s. j. (2005), Electric Machinery Fundamentals,4th Edition, McGraw-Hill.
2. Fitzgerald A. E. (2003), Electric Machinery, 6h Edition, McGraw-Hill

**2- Essential References.**

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1. D.F. Warne (2000), Newnes Electrical Engineer's Handbook, 1st Edition, Biddles Ltd- wwv. biddlesxo. Uk.
2. Nasar S. A. (1998), Electric machines and electromechanics, 2nd Edition, Schaum's outlines series- McGraw-Hill.
3. Bandyopadhyay M.N, (2009), ELECTRICAL MACHINES: THEORY AND PRACTICE, 1st Edition, Prentice-hall Of India Pvt Ltd.
4. Bimbhra P.S.,(1995), Electric Machinery , 7th Edition Khanna Publishers
5. M G Say, "Alternating current machines",4th edition, Pitman publishing Ltd.

**3- Electronic Materials and Web Sites etc.**

1. Modelica Association (2000). ModelicaTM - A Unified Object-Oriented Language for Physical Systems Modeling. Tutorial Version 1.4 (ModelicaTutorial14.pdf). Available from: https://modelica.org/documents/
2. MapleSim Video Tutorial: Modelica Video lectures available form: http://www.youtube.com/watch?v=reehU1dzeDc.
3. Simulink-Matlab tutorial for beginners Video lectures available form:
4. http://www.youtube.com/results?search_query=simulink+tutorial+for+beginners&oq=simulink&gs_l=youtube.1.9.0l10.337429.342148.0.351270.8.8.0.0.0.0.738.2481.3j3-2j2j0j1.8.0...0.0...1ac.1.11.youtube.iIK7kMX6hfo

## X. Course Policies:

| | |
|---|---|
| **1.** | **Class Attendance:** A student should attend not less than 75 % of total hours of the subject; otherwise he will not be able to take the exam and will be considered as exam failure. If the student is absent due to illness, he/she should bring an approved statement from university Clinic |
| **2.** | **Tardy:** For late in attending the class, the student will be initially notified. If he repeated lateness in attending class he will be considered as absent. |
| **3.** | **Exam Attendance/Punctuality:** A student should attend the exam on time. He is Permitted to attend an exam half one hour from exam beginning, after that he/she will not be permitted to take the exam and he/she will be considered as absent in exam- |
| **4.** | **Assignments & Projects:** The assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time- |
| **5.** | **Cheating:** |

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| | |
|---|---|
| | For cheating in exam, a student will be considered as failure. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty- |
| **6.** | **Plagiarism:**<br>Plagiarism is the attending of a student the exam of a course instead of another student. If the examination committee proved a plagiarism of a student, he will be disengaged from the Faculty. The final disengagement of the student from the Faculty should be confirmed from the Student Council Affair of the university. |
| **7.** | **Other policies:**<br>- Mobile phones are not allowed to use during a class lecture. It must be closed, otherwise the student will be asked to leave the lecture room<br>- Mobile phones are not allowed in class during the examination.<br>Lecture notes and assignments my given directly to students using soft or hard copy |

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# 36. Course Specification of Power Transmission Systems

| I. Course Identification and General Information: | | | | | | |
|---|---|---|---|---|---|---|
| **1.** | Course Title: | Power Transmission Systems | | | | |
| **2.** | Course Code &Number | PME231 | | | | |
| **3.** | Credit hours: | C.H | | | | Total |
| | | Th. | Tu. | Pr. | Tr. | |
| | | 2 | 2 | - | - | 3 |
| **4.** | Study level/ semester at which this course is offered: | Third year/ Second Semester | | | | |
| **5.** | Pre –requisite (if any): | Electrical circuits 2 (PME112) | | | | |
| **6.** | Co –requisite (if any): | Electrical Machines 2 (PME224) | | | | |
| **7.** | Program (s) in which the course is offered: | Electrical Power and Machines Engineering | | | | |
| **8.** | Language of teaching the course: | English | | | | |
| **9.** | Location of teaching the course: | Class | | | | |
| **10.** | Prepared By: | Asst. Prof. Dr. Eng. Mohammad Ali Nasr Saif | | | | |
| **11.** | Date of Approval | | | | | |

## II. Course Description:

This course is intended to give students full concepts about the transmission of power from the power generation plants to distribution systems. The course gives the ideas of the transmission
systems which enable the students to design the power transmission lines. It is intended to enhance students' knowledge of electrical power transmission and develop skills.
The course topics focus on fundamentals, calculations and analysis of transmission systems, including parameters, impedance, admittance, voltage, current and powers of transmission systems and their components also the use of different techniques, laws, and theorems to analyze their types.

| III. Course Intended learning outcomes (CILOs) of the course | Referenced PILOs |
|---|---|

| | | |
|---|---|---|
| **a1** | Define the different types of cables used in underground and overhead transmission lines. | A1 |
| **a2** | Define the effect of the parameters, series impedance and shunt admittance of a transmission line on the line performance | A1 |
| **b1** | Perform the calculation techniques of a transmission system using normal and per unit systems of calculations. | B1 |
| **b2** | Perform the calculation of the length and propagation velocity of the travelling waves of the transmission line. | B2 |
| **c1** | Obtain the value of series inductance and shunt capacitance of a transmission line. | C1 |
| **c2** | Differentiate between the approximate and exact solutions of analyzing transmission lines. | C3 |
| **d1** | Communicate computer and internet to extract information related to his field of study. | D5 |
| **d2** | Evaluate the text books and materials related to the power transmission field using faculty library and computer and internet resources for self-learning activities and enhance the learning progress. | D5 |

**(A) Alignment Course Intended Learning Outcomes of Knowledge and Understanding to Teaching Strategies and Assessment Strategies:**

| Course Intended Learning Outcomes | Teaching strategies | Assessment Strategies |
|---|---|---|
| **a1-** Define the different types of cables used in underground and overhead transmission lines. | ▪ Lecture,<br>▪ Tutorials,<br>▪ Interactive class discussion,<br>▪ Homework | ▪ Assignments,<br>▪ Written exams,<br>▪ Quizzes,<br>▪ Written report |
| **a2-** Define the effect of the parameters, series impedance and shunt admittance of a transmission line on the line performance. | | |

**(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:**

| Course Intended Learning Outcomes | Teaching strategies | Assessment Strategies |
|---|---|---|

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| | | |
|---|---|---|
| **b1-** Perform the calculation techniques of a transmission system using normal and per unit systems of calculations. | ▪ Lecture,<br>▪ Tutorials,<br>▪ Interactive class discussion,<br>▪ Homework | ▪ Assignments,<br>▪ Written exams,<br>▪ Quizzes,<br>▪ Written report |
| **b2-** Perform the calculation of the length and propagation velocity of the travelling waves of the transmission line. | | |

| **©Alignment Course Intended Learning Outcomes of Professional and Practical Skills to Teaching Strategies and Assessment Strategies:** | | |
|---|---|---|
| Course Intended Learning Outcomes | Teaching strategies | Assessment Strategies |
| **c1-** Obtain the value of series inductance and shunt capacitance of a transmission line. | ▪ Lecture,<br>▪ Tutorials,<br>▪ Interactive class discussion,<br>▪ Homework | ▪ Assignments,<br>▪ Written exams,<br>▪ Quizzes,<br>▪ Written report |
| **c2-** Differentiate between the approximate and exact solutions of analyzing transmission lines. | | |

| **(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:** | | |
|---|---|---|
| Course Intended Learning Outcomes | Teaching strategies | Assessment Strategies |
| **d1-** Communicate computer and internet to extract information related to his field of study. | ▪ Lecture,<br>▪ Tutorials,<br>▪ Interactive class discussion,<br>▪ Homework | ▪ Assignments,<br>▪ Written exams,<br>▪ Quizzes,<br>▪ Written report |
| **d2-** Evaluate the text books and materials related to the power transmission field using faculty library and computer and internet resources for self-learning activities and enhance the learning progress. | | |

## IV. Course Content:

### A – Theoretical Aspect:

| Order | Units/Topics List | Learning Outcomes | Sub Topics List | Number of Weeks | Contact hours |
|---|---|---|---|---|---|
| **1.** | Basic concepts of power system elements | a1, b1 | ▪ AC concept and representation of a system voltage and current.<br>▪ Powers in 1- and 3-phase systems.<br>▪ Complex power, power triangle and power factor correction.<br>▪ Direction of power flow in a system.<br>▪ Voltage and current for balanced and unbalanced system.<br>▪ Per unit calculation system.<br>▪ Per unit values of 1-phase and 3-phase electrical quantities. | 2 | 4 |
| **2.** | Series impedance of transmission lines | a1,a2,b2,c1 | ▪ Series parameters of transmission lines.<br>▪ Inductance of one conductor of a transmission line.<br>▪ Inductance of 1-phase 2-wire transmission line.<br>▪ Inductance of composite conductor lines. | 2 | 4 |

| | | | | | |
|---|---|---|---|---|---|
| | | | ▪ Inductance of a 3-phase line with equilateral and inequilaterally spacing.<br>▪ Inductance of a 3-phase line with horizontal and vertical flat spacing.<br>▪ Inductance of a 3-phase parallel-circuit lines. | | |
| **3.** | Shunt admittance of transmission lines | a1,a2,b2,c1 | ▪ Shunt parameters of transmission lines:<br>▪ Electric field of a long straight conductor of the transmission line.<br>▪ Capacitance of 1-phase 2-wire transmission line.<br>▪ Capacitance of a 3-phase line with equilateral and inequilaterally spacing.<br>▪ Calculation of inductance and capacitance of ACSR line conductor by derived formula or by standard provided tables. | 2 | 4 |
| **4.** | Overhead 3-phase power transmission lines | a2, ,b1,b2, c1,c2 | ▪ Classification of overhead transmission lines according to length. | 3 | 6 |

| | | | | | |
|---|---|---|---|---|---|
| | | | ▪ Approximate solution of short and medium transmission lines.<br>▪ Exact solution of transmission lines.<br>▪ Generalized constants of transmission lines<br>▪ Performance equations of transmission lines using approximate and exact solutions.<br>▪ Analysis of transmission lines using their performance equations and phasor and circle diagrams.<br>▪ Series and shunt reactive compensation of transmission lines. | | |
| **5.** | Travelling waves on overhead transmission lines | a1, b1 | ▪ Incident and reflected waves of the transmission line voltage and current.<br>▪ Calculation of the length and propagation speed of the incident and reflected travelling waves.<br>▪ Incident and reflected waves on short-circuited transmission lines. | 1 | 2 |
| **6.** | Representation of transmission lines | a1,a2,b1,b2 | ▪ Power system one-line diagram components. | 1 | 2 |

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| | on power system diagram. | | ▪ Impedance and reactance diagrams of one-line diagrams with per unit and actual values.<br>▪ Analysis of one-line diagram using its impedance and reactance diagrams. | | |
| **7.** | Mechanical design of power overhead transmission lines | a1, b1,d1,d2 | ▪ Calculation of sag and tension for flat transmission lines.<br>▪ Effect of wind and ice covering transmission lines.<br>▪ Span of transmission line in hilly area. | 2 | 4 |
| **8.** | Insulator of overhead transmission lines | a1,c2,d1,d2 | ▪ Important role of insulator in the transmission line operation.<br>▪ Insulator types and materials.<br>▪ Advantages of suspension type insulator.<br>▪ Voltage distribution across insulator strings.<br>▪ Method of equalizing voltage distribution across insulator strings. | 1 | 2 |
| **Number of Weeks /and Units Per Semester** | | | | **14** | **28** |

| B – Tutorial Aspect: | | | | |
|---|---|---|---|---|
| **Order** | **Tasks/ Experiments** | **Number of Weeks** | **Contact hours** | **Learning Outcomes** |
| **1.** | ▪ Powers in 1- and 3-phase systems.<br>▪ Complex power, power triangle and power factor correction.<br>▪ Direction of power flow in a system.<br>▪ Voltage and current for balanced and unbalanced system. | **2** | **4** | **a1** |
| **2.** | ▪ conductor of a transmission line.<br>▪ Inductance of 1-phase 2-wire transmission line.<br>▪ Inductance of composite conductor lines.<br>▪ Inductance of a 3-phase line with equilateral and inequilaterally spacing.<br>▪ Inductance of a 3-phase line with horizontal and vertical flat spacing.<br>▪ Inductance of a 3-phase parallel-circuit lines. | **3** | **6** | **a2,b2** |
| **3.** | ▪ Capacitance of 1-phase 2-wire transmission line.<br>▪ Capacitance of a 3-phase line with equilateral and inequilaterally spacing.<br>▪ Calculation of inductance and capacitance of ACSR line conductor by derived formula or by standard provided tables. | **2** | **4** | **a1,b1,b2** |
| **4.** | ▪ Exact solution of transmission lines.<br>▪ Generalized constants of transmission lines<br>▪ Performance equations of transmission lines using approximate and exact solutions.<br>▪ Analysis of transmission lines using their performance equations and phasor and circle diagrams.<br>▪ Series and shunt reactive compensation of transmission lines. | **2** | **4** | a1, b2 |
| **5.** | ▪ Calculation of the length and propagation speed of the incident and reflected travelling waves. | **2** | **4** | **a1,a2,d1** |

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Quality Assurance Unit
Assoc. Prof. Dr. Mohammad Algorafi

Dean of the Faculty
Prof. Dr. Mohammed AL-Bukhaiti

Academic Development Center & Quality Assurance
Assoc. Prof. Dr. Huda Al-Emad

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas

| | | | | |
|---|---|---|---|---|
| | ▪ Incident and reflected waves on short-circuited transmission lines. | | | |
| **6.** | ▪ Impedance and reactance diagrams of one-line diagrams with per unit and actual values.<br>▪ Analysis of one-line diagram using its impedance and reactance diagrams. | **2** | **4** | **a2,d2** |
| **7.** | ▪ Review | **1** | **2** | **b1,b2,d1** |
| **Number of Weeks /and Units Per Semester** | | **14** | **28** | |

## V. Teaching strategies of the course:

- Lectures
- Dialogue and discussion
- Brainstorming
- Problem Solving

## VI. Assignments:

| No | Assignments | Aligned CILOs(symbols) | Week Due | Mark |
|---|---|---|---|---|
| **1.** | Exercises 1 | a1, b1,d1,d2 | 4 | 3.5 |
| **2.** | Exercises 2 | a1,a2,b1, b2 | 8 | 3.5 |
| **3.** | Exercises 3 | a1,a2,b1, b2,b3,.d1 | 12 | 3 |
| **Total** | | | | **10** |

## VII. Schedule of Assessment Tasks for Students During the Semester:

| No. | Assessment Method | Week Due | Mark | Proportion of Final Assessment | Aligned Course Learning Outcomes |
|---|---|---|---|---|---|
| **1.** | Assignments | 4,8,12 | 10 | 6.7% | a1, a2,b1, b2,d1,d2. |
| **2.** | Quiz (1) | 5 | 10 | 6.7% | a1, a2 , b1, b2. |
| **3.** | Midterm Exam | 7 | 30 | 20% | a1,a2 b1, b2 |
| **4.** | Quiz (1) | 10 | 10 | 6.7% | a1,a2 b1, b2 |
| **5.** | Final Exam (theoretical) | 16 | 90 | 60% | a1, a2, b1, b2 |
| | **Total grades** | | **150** | **100%** | |

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## VIII. Learning Resources:

- *Written in the following order: ( Author - Year of publication – Title – Edition – Place of publication – Publisher).*

**1- Required Textbook(s) ( maximum two ).**

**1-** John J. Grainger & William D. Stevenson, 1994, Power System Analysis,5 Ed, McGRAW-HILL, New York , USA,

**2- Essential References.**

**1-** Ashfaq Husain, 2007, Electrical Power Systems, 5th Ed CBS Publishers & Distributers, New Delhi, USA. India.

**2-** Dr B. R. Gupta, 2015, Power System Analysis and Design, S Chand & Company Ltd. (India).

**3- Electronic Materials and Web Sites *etc*.**

1. All Site concerning with Power Transmission Information &Textbooks

## IX. Course Policies:

| | |
|---|---|
| **1.** | **Class Attendance:** A student should attend not less than 75 % of total hours of the subject; otherwise he will not be able to take the exam and will be considered as exam failure. If the student is absent due to illness, he/she should bring an approved statement from university Clinic |
| **2.** | **Tardy:** For late in attending the class, the student will be initially notified. If he repeated lateness in attending class he will be considered as absent. |
| **3.** | **Exam Attendance/Punctuality:** A student should attend the exam on time. He is Permitted to attend an exam half one hour from exam beginning, after that he/she will not be permitted to take the exam and he/she will be considered as absent in exam- |
| **4.** | **Assignments & Projects:** The assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time- |
| **5.** | **Cheating:** For cheating in exam, a student will be considered as failure. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty- |
| **6.** | **Plagiarism**: |

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| | |
|---|---|
| | Plagiarism is the attending of a student the exam of a course instead of another student. If the examination committee proved a plagiarism of a student, he will be disengaged from the Faculty. The final disengagement of the student from the Faculty should be confirmed from the Student Council Affair of the university. |
| **7.** | **Other policies:**<br>- Mobile phones are not allowed to use during a class lecture. It must be closed, otherwise the student will be asked to leave the lecture room<br>- Mobile phones are not allowed in class during the examination.<br>Lecture notes and assignments my given directly to students using soft or hard copy |

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|---|---|
| **Reviewed By** | **Vice Dean for Academic Affairs and Post Graduate Studies: Asst. Prof. Dr. Tarek A. Barakat**<br>**President of Quality Assurance Unit: Assoc. Prof. Dr. Mohammed Algorafi**<br>**Name of Reviewer from the Department: Assoc. Prof. Dr. Radwan Al bouthigy** |
| | **Deputy Rector for Academic Affairs Asst. Prof. Dr. Ibrahim AlMutaa**<br>**Assoc. Prof. Dr. Ahmed Mujahed**<br>**Asst. Prof. Dr. Munasar Alsubri** |

| | | | | |
|---|---|---|---|---|
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# 36. Template for Course Plan of Power Transmission Systems

| I. Information about Faculty Member Responsible for the Course: | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Name of Faculty Member** | Asst. Prof. Dr. Eng. Mohammad Ali Nasr Saif | **Office Hours** | | | | | |
| **Location& Telephone No.** | Faculty of Engineering | **SAT** | **SUN** | **MON** | **TUE** | **WED** | **THU** |
| **E-mail** | dmansaif@gmail.com | | | | | | 9-12 |

| II. Course Identification and General Information: | | | | | | |
|---|---|---|---|---|---|---|
| **1.** | Course Title: | Power Transmission Systems | | | | |
| **2.** | Course Number & Code: | PME231 | | | | |
| **3.** | Credit hours: | C.H | | | | Total |
| | | Th. | Tu. | Pr. | Tr. | |
| | | 2 | 2 | - | - | 3 |
| **4.** | Study level/year at which this course is offered: | Third year/ Second Semester | | | | |
| **5.** | Pre –requisite (if any): | Electrical Circuits 2 (PME112) | | | | |
| **6.** | Co –requisite (if any): | Electrical Machines 2 (PME224) | | | | |
| **7.** | Program (s) in which the course is offered | Electrical Power and Machines Engineering | | | | |
| **8.** | Language of teaching the course: | English | | | | |
| **9.** | System of Study: | Regular | | | | |

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| | | |
|---|---|---|
| **10.** | Mode of delivery: | Semester |
| **11.** | Location of teaching the course: | Class |

## III. Course Description:

This course is intended to give students full concept about the transmission of power from the power generation plants to distribution systems. The course gives the ideas of the transmission systems which enable the students to design the power transmission lines. It is intended to enhance students' knowledge of electrical power transmission and develop skills.
The course topics focus on fundamentals, calculations and analysis of transmission systems, including parameters, impedance, admittance, voltage, current and powers of transmission systems and their components also the use of different techniques, laws, and theorems to analyze their types.

## IV. Intended learning outcomes (ILOs) of the course:

- Brief summary of the knowledge or skill the course is intended to develop**:**

1. Define the different types of cables used in underground and overhead transmission lines.
2. Define the effect of the parameters, series impedance and shunt admittance of a transmission line on the line performance
3. Perform the calculation techniques of a transmission system using normal and per unit systems of calculations.
4. Perform the calculation of the length and propagation velocity of the travelling waves of the transmission line.
5. Obtain the value of series inductance and shunt capacitance of a transmission line.
6. Differentiate between the approximate and exact solutions of analyzing transmission lines.
7. Communicate computer and internet to extract information related to his field of study.
8. Evaluate the text books and materials related to the power transmission field using faculty library and computer and internet resources for self-learning activities and enhance the learning progress.

## V. Course Content:

### A – Theoretical Aspect:

| Order | Units/Topics List | Sub Topics List | Number of Weeks | Contact hours |
|---|---|---|---|---|
| **1.** | Basic concepts of power system elements | ▪ AC concept and representation of a system voltage and current.<br>▪ Powers in 1- and 3-phase systems.<br>▪ Complex power, power triangle and power factor correction.<br>▪ Direction of power flow in a system.<br>▪ Voltage and current for balanced and unbalanced system.<br>▪ Per unit calculation system.<br>▪ Per unit values of 1-phase and 3-phase electrical quantities. | 1st ,2nd | 4 |
| **2.** | Series impedance of transmission lines | ▪ Series parameters of transmission lines.<br>▪ Inductance of one conductor of a transmission line.<br>▪ Inductance of 1-phase 2-wire transmission line.<br>▪ Inductance of composite conductor lines.<br>▪ Inductance of a 3-phase line with equilateral and inequilaterally spacing.<br>▪ Inductance of a 3-phase line with horizontal and vertical flat spacing.<br>▪ Inductance of a 3-phase parallel-circuit lines. | 3rd ,4th | 4 |
| **3.** | Shunt admittance of transmission lines | ▪ Shunt parameters of transmission lines:<br>▪ Electric field of a long straight conductor of the transmission line.<br>▪ Capacitance of 1-phase 2-wire transmission line.<br>▪ Capacitance of a 3-phase line with equilateral and inequilaterally spacing.<br>▪ Calculation of inductance and capacitance of ACSR line conductor by derived formula or by standard provided tables. | 5th ,6th | 4 |

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| **4.** | Mid-Term Exam | ▪ Covers all sub topics up to the 6th week. | 7th | 2 |
| **5.** | Overhead 3-phase power transmission lines | ▪ Classification of overhead transmission lines according to length.<br>▪ Approximate solution of short and medium transmission lines.<br>▪ Exact solution of transmission lines.<br>▪ Generalized constants of transmission lines<br>▪ Performance equations of transmission lines using approximate and exact solutions.<br>▪ Analysis of transmission lines using their performance equations and phasor and circle diagrams.<br>▪ Series and shunt reactive compensation of transmission lines. | 8th ,9th ,10th | 6 |
| **6.** | Travelling waves on overhead transmission lines | ▪ Incident and reflected waves of the transmission line voltage and current.<br>▪ Calculation of the length and propagation speed of the incident and reflected travelling waves.<br>▪ Incident and reflected waves on short-circuited transmission lines. | 11th | 2 |
| **7.** | Representation of transmission lines on power system diagram. | ▪ Power system one-line diagram components.<br>▪ Impedance and reactance diagrams of one-line diagrams with per unit and actual values.<br>▪ Analysis of one-line diagram using its impedance and reactance diagrams. | 12th | 2 |
| **8.** | Mechanical design of power overhead transmission lines | ▪ Calculation of sag and tension for flat transmission lines.<br>▪ Effect of wind and ice covering transmission lines.<br>▪ Span of transmission line in hilly area. | 13th ,14th | 4 |
| **9.** | Insulator of overhead transmission lines | ▪ Important role of insulator in the transmission line operation.<br>▪ Insulator types and materials.<br>▪ Advantages of suspension type insulator. | 15th | 2 |

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| | | ▪ Voltage distribution across insulator strings.<br>▪ Method of equalizing voltage distribution across insulator strings. | | |
| **10.** | Final Exam | ▪ All Topics | 16th | 2 |
| **Number of Weeks /and Units Per Semester** | | | **16** | **32** |

**B – Tutorial Aspect:**

| Order | Tasks/ Experiments | Number of Weeks | Contact hours |
|---|---|---|---|
| **1.** | ▪ Powers in 1- and 3-phase systems.<br>▪ Complex power, power triangle and power factor correction.<br>▪ Direction of power flow in a system.<br>▪ Voltage and current for balanced and unbalanced system. | **1st ,2nd** | **4** |
| **2.** | ▪ conductor of a transmission line.<br>▪ Inductance of 1-phase 2-wire transmission line.<br>▪ Inductance of composite conductor lines.<br>▪ Inductance of a 3-phase line with equilateral and inequilaterally spacing.<br>▪ Inductance of a 3-phase line with horizontal and vertical flat spacing.<br>▪ Inductance of a 3-phase parallel-circuit lines. | **3rd ,4th ,5th** | **6** |
| **3.** | ▪ Capacitance of 1-phase 2-wire transmission line.<br>▪ Capacitance of a 3-phase line with equilateral and inequilaterally spacing.<br>▪ Calculation of inductance and capacitance of ACSR line conductor by derived formula or by standard provided tables. | **6th ,7th** | **4** |
| **4.** | ▪ Exact solution of transmission lines.<br>▪ Generalized constants of transmission lines<br>▪ Performance equations of transmission lines using approximate and exact solutions.<br>▪ Analysis of transmission lines using their performance equations and phasor and circle diagrams. | **8th ,9th** | **4** |

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| | ▪ Series and shunt reactive compensation of transmission lines. | | |
| **5.** | ▪ Calculation of the length and propagation speed of the incident and reflected travelling waves.<br>▪ Incident and reflected waves on short-circuited transmission lines. | **2** | **4** |
| **6.** | ▪ Impedance and reactance diagrams of one-line diagrams with per unit and actual values.<br>▪ Analysis of one-line diagram using its impedance and reactance diagrams. | **2** | **4** |
| **7.** | ▪ Review | **1** | **2** |
| **Number of Weeks /and Units Per Semester** | | **14** | **28** |

## VI. Teaching strategies of the course:

- Lectures
- Dialogue and discussion
- Brainstorming
- Problem Solving

## VII. Assignments:

| No | Assignments | Aligned CILOs(symbols) | Week Due | Mark |
|---|---|---|---|---|
| **1.** | Exercises 1 | a1, b1,d1,d2 | 4 | 3.5 |
| **2.** | Exercises 2 | a1,a2,b1, b2 | 8 | 3.5 |
| **3.** | Exercises 3 | a1,a2,b1, b2,b3,.d1 | 12 | 3 |
| **Total** | | | | **10** |

## VIII. Schedule of Assessment Tasks for Students During the Semester:

| No. | Assessment Method | Week Due | Mark | Proportion of Final Assessment | Aligned Course Learning Outcomes |
|---|---|---|---|---|---|
| **1.** | Assignments | 4,8,12 | 10 | 6.7% | a1, a2,b1, b2,d1,d2. |
| **2.** | Quiz (1) | 5 | 10 | 6.7% | a1, a2 , b1, b2. |

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| **3.** | Midterm Exam | 7 | 30 | 20% | a1,a2 b1, b2 |
| **4.** | Quiz (1) | 10 | 10 | 6.7% | a1,a2 b1, b2 |
| **5.** | Final Exam (theoretical) | 16 | 90 | 60% | a1, a2, b1, b2 |
| | **Total grades** | | **150** | **100%** | |

## IX. Learning Resources:

- *Written in the following order: ( Author - Year of publication – Title – Edition – Place of publication – Publisher).*

**1- Required Textbook(s) ( maximum two ).**

1. John J. Grainger & William D. Stevenson, 1994, Power System Analysis,5 Ed, McGRAW-HILL, New York , USA,

**2- Essential References.**

1. Ashfaq Husain, 2007, Electrical Power Systems, 5th Ed CBS Publishers & Distributers, New Delhi, USA. India.
2. Dr B. R. Gupta, 2015, Power System Analysis and Design, S Chand & Compan Pvt. Ltd. (India).

**3- Electronic Materials and Web Sites *etc*.**

1- All Site concerning with Power Transmission Information &Textbooks

## X. Course Policies:

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| **1.** | **Class Attendance:** A student should attend not less than 75 % of total hours of the subject; otherwise he will not be able to take the exam and will be considered as exam failure. If the student is absent due to illness, he/she should bring an approved statement from university Clinic |
| **2.** | **Tardy:** For late in attending the class, the student will be initially notified. If he repeated lateness in attending class he will be considered as absent. |
| **3.** | **Exam Attendance/Punctuality:** A student should attend the exam on time. He is Permitted to attend an exam half one hour from exam beginning, after that he/she will not be permitted to take the exam and he/she will be considered as absent in exam- |
| **4.** | **Assignments & Projects:** |

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| | The assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time- |
| **5.** | **Cheating:**<br>For cheating in exam, a student will be considered as fail. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty- |
| **6.** | **Plagiarism**:<br>Plagiarism is the attending of a student the exam of a course instead of another student. If the examination committee proved a plagiarism of a student, he will be disengaged from the Faculty. The final disengagement of the student from the Faculty should be confirmed from the Student Council Affair of the university. |
| **7.** | **Other policies:**<br>- Mobile phones are not allowed to use during a class lecture. It must be closed, otherwise the student will be asked to leave the lecture room<br>- Mobile phones are not allowed in class during the examination.<br>Lecture notes and assignments my given directly to students using soft or hard copy |

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