University of Sana'a
Faculty of Engineering
Department: Electrical Engineering
Title of the Program: Electrical Power and Machines Engineering

Course Specification of Planning and Operation of Electrical Power System

I. Course Identification and General Information:

1.	Course Title:	Planning and Operation of Electrical Power System				
2.	Course Code & Number:	PME435				
3.	Credit hours:	C.H				Total
		Th.	Tu.	Pr.	Tr.	
		2	2	-	-	3
4.	Study level/ semester at which this course is offered:	Fifth Year/ First Semester				
5.	Pre –requisite (if any):	BR232, PME231 and FR304				
6.	Co –requisite (if any):	None.				
7.	Program (s) in which the course is offered:	Electrical Power and Machines Engineering				
8.	Language of teaching the course:	Arabic and English				
9.	Location of teaching the course:	Education Building / Lecture room				
10.	Prepared By:	Assoc. Prof. Dr. Ahmed Al Arashi				
11.	Date of Approval					

II. Course Description:

This is an advanced course for power engineers where the y will practice large amount of power system knowledge, they learned over the first four years. It will introduce the students to problem of power system planning issues in various power system parts over the different time horizon. General planning procedures, tools for long, medium and short range planning.

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Assoc. Prof. Dr. Ahmed Al Arashi	Asst. Prof. Dr. Adel Ahmed Al-Shakiri	Assoc. Prof. Dr. Mohammad Algorafi	Prof. Dr. Mohammed AL-Bukhaiti	Assoc. Prof. Dr. Huda Al-Emad

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III. Course Intended learning outcomes (CILOs) of the course		Referenced PILOs
a1	Describe power system planning steps covering elements, methods and rules related to modern power systems.	A2: Understand principles of design including elements, processes and/or systems related to Power Engineering and Electrical Machines.
a2	Understand the modern power system de-regulation.	A3: Acquire knowledge of contemporary issues.
b1	Formulate engineering problems raised by power system Planning	B1: Identify, formulate, and solve engineering problems related to Power Engineering and Electrical Machines.
b2	Take care of economic, social and environmental issues while planning for new power system	B4: Consider economic, social and environmental dimensions in engineering design related to Power Engineering and Electrical Machines.
c1	Plan electrical power system to fulfill all condition stated by International Standards	C2: Design, model and simulate electrical systems to meet desired needs within realistic constrains.
c2	Apply simulation programs to meet the increase of needs for more power system design and planning	C4:Use modern engineering techniques, skills and computing tools related to Power Engineering and Electrical Machines.
d1	Ability to engage in self presentation and life-long learning.	D2: Engage in independent lifelong learning.
d2	Use effectively information resources and literature	D5. Conduct searches of literature

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(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-	Describe power system planning steps covering elements, methods and rules related to modern power systems.	Lectures, Tutorial, Interactive Class Discussions, Self-Study. Homework	Assignments, Written Exams, Quizzes
a2-	Understand the modern power system de-regulation.	Lectures, Tutorial, Interactive Class Discussions, Self-Study. Homework	Assignments, Written Exams, Quizzes

(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:			
Course Intended Learning Outcomes		Teaching strategies	Assessment Strategies
b1-	Formulate engineering problems raised by power system Planning	Lectures, Interactive class discussions, Homework, Self and cooperative learning.	Assignments, Quizzes, Written exams, Homework. Mini Project
b2-	Take care of economic, social and environmental issues while planning for new power system	Lectures, Interactive class discussions, Homework, Mini project Self and cooperative learning.	Assignments, Quizzes, Written exams, Homework, Mini Project

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© 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- Plan electrical power system to fulfill all condition stated by International Standards	Lectures, Interactive class discussion Exercises, Self-study assignments and homework.	Quizzes assignments and reports, Homework, Mini Project Midterm and final exam.
C2- Apply simulation programs to meet the increase of needs for more power system design and planning	Lectures, Interactive class discussion Exercises, Self-study assignments and homework.	Quizzes Homework, Midterm and final exam.

(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
d1- Ability to engage in self presentation and life-long learning.	Lectures, Interactive class discussion Exercises, Self-study assignments and homework.	Quizzes Homework, Midterm and final exam.
d2- Use effectively information resources and literature	Lectures, Interactive class discussion Exercises, Self-study assignments and homework.	Quizzes assignments and reports, Homework, Mini Project Midterm and final exam.

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IV. Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	Contact hours
1.	Power system planning	a1, a,2, b1, b2	▪ Introduction ▪ Planning Basic Steps. ▪ Long, Medium, and short-range Planning. ▪ Planning Technic. ▪ Load forecasting technichis.	3	6
2.	Consideration for long and medium range planning.	a1, a,2, b1, b2, c2	▪ Generation Planning ▪ Load Forecasting ▪ Relationship Between Capacity Reserves and Reliability. ▪ Capacity Resource Planning ▪ Transmission Planning ▪ Rotor-Angle Stability. ▪ Voltage Stability. ▪ Frequency Stability ▪ Distribution System Planning ▪ Load Forecasting ▪ Planning for Reliability.	2	4
3.	Impact of renewable energy on Generation.	a1, a,2, b1, b2, c1, c2	▪ Impact of Variable Renewable Energy Generation ▪ Implications on Generation Planning ▪ Capacity ▪ Characterizing the Net Load ▪ Characterizing the Impact on Fuel Mix ▪ Generation Flexibility	2	4

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4.	Impact of renewable energy on Transmission	a1, a,2, b1, b2, c1, c2, d1	▪ Implications for Transmission Planning. ▪ Common Characteristics of PV Inverters. ▪ PV Inverters' Behavior During Grid Faults ▪ Modeling PV Inverters for Transmission Planning.	3	6
5.	Impact of renewable energy on Distribution	a1, a,2, b1, b2, c1, c2, d1	▪ Implications for Distribution Planning and Engineering. ▪ Feeder Voltage Regulation. ▪ Contributions to Fault Currents and Protection Desensitization ▪ Ungrounded Source of Voltage. ▪ Software Tools Used in Distribution Engineering.	2	4
6.	Short term planning	a1, a,2, b1, b2, c1, c2, d1, d2	▪ Introduction. ▪ Objective and Conditions ▪ Planning Problems ▪ Thermal Power Plants as an Example. ▪ Generation Cost. ▪ Operation Constraints ▪ Some Unit Commitment Problems ▪ Dual Variables	2	4
Number of Weeks /and Units Per Semester				**14**	**28**

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B - Tutorial Aspect:				
Order	**Tasks/ Experiments**	**Number of Weeks**	**Contact hours**	**Learning Outcomes**
1.	Introduction to Power system packages	2	4	a1, a,2, b1, b2
2.	Load flow	3	6	a1, a,2, c1, c2
3.	Fault analysis	3	6	a1, a,2, b1, b2, d1
4.	Stability analysis	3	6	a1, a,2, b1, b2, d1
5.	Hybrid Generation	3	6	a1, a,2, b1, b2, c1, c2
Number of Weeks /and Units Per Semester		**14**	**28**	

V. Teaching strategies of the course:

- Lectures,
- Interactive class discussions,
- Homework,
- Mini project
- Self and cooperative learning.

VI. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1.	Mini Project 1	a1, a,2, c1, c2	3rd	4
2.	Mini Project 2	a1, a,2, c1, c2	5th	4.5
3.	Mini Project 3	a1, a,2, c1, c2	7th	4.5
4.	Mini Project 4	a1, a,2, c1, c2	11th	4.5
5.	Mini Project 5	a1, a,2, c1, c2, d2	13th	5
	Total			**22.5**

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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	3,4,5,6,7	22.5	15%	a1, a,2, c1, c2, d2
2.	Assignment	10	22.5	15%	a1, a,2, c1, c2, d2
3.	Med term	8	15	10%	a1, a,2, c1, c2, d2
4.	Final Exam	13	90	60%	a1, a,2, b1, b2, c1, c2, d1, d2
	Total		**150**	**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- J. Bebic, 2008, Power System Planning: Emerging Practices Suitable for Evaluating the Impact of High-Penetration Photovoltaics., Niskayuna, New York, GE Global Research.
2- Lennart Söder and Mikael Amelin,2011, "Efficient Operation and Planning of Power System", 11th edition, Stockholm, Royal Institute of Technology Electric Power Systems.

2- Essential References.

-

3- Electronic Materials and Web Sites *etc*.

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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 a proof 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 fail. 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 proofed 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:** - 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 - Mobile phones are not allowed in class during the examination. 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** **President of Quality Assurance Unit: Assoc. Prof. Dr. Mohammed Algorafi** **Name of Reviewer from the Department: Asst. Prof. Dr. Adel Ahmed Al-Shakiri**
	Deputy Rector for Academic Affairs Asst. Prof. Dr. Ibrahim AlMutaa **Assoc. Prof. Dr. Ahmed Mujahed** **Asst. Prof. Dr. Munasar Alsubri**

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Template for Course Plan of Planning and Operation of Electrical Power System

I. - Information about Faculty Member Responsible for the Course:							
Name of Faculty Member	Dr. Ahmed Al Arashi	**Office Hours**					
Location& Telephone No.	Electrical Engineering Department	**SAT**	**SUN**	**MON**	**TUE**	**WED**	**THU**
E-mail							

II. Course Identification and General Information:						
1.	Course Title:	Planning and Operation of Electrical Power System				
2.	Course Number & Code:	PME435				
3.	Credit hours:	C.H				Total
		Th.	Tu.	Pr.	- Tr.	
		2	2	-	-	3
4.	Study level/year at which this course is offered:	Fifth Year/ First Semester				
5.	Pre –requisite (if any):	BR232, PME231 and FR304				
6.	Co –requisite (if any):	None.				
7.	Program (s) in which the course is offered	Electrical Power and Machines Engineering				
8.	Language of teaching the course:	Arabic and English				
9.	System of Study:	Regular				

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10.	Mode of delivery:	Lecture
11.	Location of teaching the course:	Education Building / Lecture room

III. Course Description:

This is an advanced course for power engineers where the y will practice large amount of power system knowledge, they learned over the first four years. It will introduce the students to problem of power system planning issues in various power system parts over the different time horizon. General planning procedures, tools for long, medium and short range planning.

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

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

1. Describe power system planning steps covering elements, methods and rules related to modern power systems.
2. Understand the modern power system de-regulation.
3. Formulate engineering problems raised by power system Planning
4. Take care of economic, social and environmental issues while planning for new power system
5. Plan electrical power system to fulfill all condition stated by International Standards
6. Apply simulation programs to meet the increase of needs for more power system design and planning
7. Ability to engage in self presentation and life-long learning.
8. Use effectively information resources and literature

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V. Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Sub Topics List	Number of Weeks	Contact hours
1.	Power system planning	▪ Introduction ▪ Planning Basic Steps. ▪ Long, Medium, and short-range Planning. ▪ Planning Technic. ▪ Load forecasting technichis.	1st ,2nd ,3rd	6
2.	Consideration for long and medium range planning.	▪ Generation Planning ▪ Load Forecasting ▪ Relationship Between Capacity Reserves and Reliability. ▪ Capacity Resource Planning ▪ Transmission Planning ▪ Rotor-Angle Stability. ▪ Voltage Stability. ▪ Frequency Stability ▪ Distribution System Planning ▪ Load Forecasting ▪ Planning for Reliability.	4th ,5th	4
3.	Impact of renewable energy on Generation.	▪ Impact of Variable Renewable Energy Generation ▪ Implications on Generation Planning ▪ Capacity ▪ Characterizing the Net Load ▪ Characterizing the Impact on Fuel Mix ▪ Generation Flexibility	6th ,7th	4
4.	Mid Term	▪	8th	2

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5.	Impact of renewable energy on Transmission	▪ Implications for Transmission Planning. ▪ Common Characteristics of PV Inverters. ▪ PV Inverters' Behavior During Grid Faults ▪ Modeling PV Inverters for Transmission Planning.	9th ,10th ,11th	6
6.	Impact of renewable energy on Distribution	▪ Implications for Distribution Planning and Engineering. ▪ Feeder Voltage Regulation. ▪ Contributions to Fault Currents and Protection Desensitization ▪ Ungrounded Source of Voltage. ▪ Software Tools Used in Distribution Engineering.	12th ,13th	4
7.	Short term planning	▪ Introduction. ▪ Objective and Conditions ▪ Planning Problems ▪ Thermal Power Plants as an Example. ▪ Generation Cost. ▪ Operation Constraints ▪ Some Unit Commitment Problems ▪ Dual Variables	14th ,15th	4
8.	Final Exam		16th	2
Number of Weeks /and Units Per Semester			**16**	**32**

B - Tutorial Aspect:

Order	Tasks/ Experiments	Number of Weeks	Contact hours
1.	Introduction to Power system packages	1st ,2nd	4

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2.	Load flow	3rd ,4th ,5th	6
3.	Fault analysis	6th ,7th ,8th	6
4.	Stability analysis	9th ,10th ,11th	6
5.	Hybrid Generation	12th ,13th ,14th	6
Number of Weeks /and Units Per Semester		**14**	**28**

VI. Teaching strategies of the course:

- Lectures,
- Interactive class discussions,
- Homework,
- Mini project
- Self and cooperative learning.

VII. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1.	Mini Project 1	a1, a,2, c1, c2	3rd	4
2.	Mini Project 2	a1, a,2, c1, c2	5th	4.5
3.	Mini Project 3	a1, a,2, c1, c2	7th	4.5
4.	Mini Project 4	a1, a,2, c1, c2	11th	4.5
5.	Mini Project 5	a1, a,2, c1, c2, d2	13th	5
	Total			**22.5**

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

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment
1.	Quizzes	3,4,5,6,7	22.5	15%

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2.	Assignment	10	22.5	15%
3.	Med term	8	15	10%
4.	Final Exam	13	90	60%
	Total		**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).

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2- Essential References.

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3- Electronic Materials and Web Sites *etc*.

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2.	**Tardy:**

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