Power System Analysis - Course Syllabus

Course Title: Power System Analysis	**Course Code: EEL-4413/ELE-4343**	**Credit Hours: 3**	**Pre-Requisite Topics**: Electric Machines, Electric Circuits Theory, Power Electronics, Applied Mathematics
Instructor: Dr. Haris M. Khalid		**Contact Info: Email: hkhalid@hct.ac.ae** **Website: www.harismkhalid.com**	
Course Description:	The ability to analyze and solve problems commonly encountered in electrical power systems is essential for quality power systems. A revision of complex power calculations, per-unit system of analysis, and electrical network calculations is included, and topics related to system modelling, load flow analysis, symmetrical components theory, fault analysis, and stability problems.		
Teaching & Learning Methodologies:	This course provides candidates with the theoretical knowledge of power system analysis. In addition to formal teaching and tutorial work, students should be given the opportunity to conduct system studies and run simulation programs related to power systems. Laboratory work aimed at familiarizing the students with the main theoretical concepts on load flow would be an advantage. These could be arranged as demonstrations.		
Course Resources:	No Textbook Specified		

Course Learning Outcomes	Program Learning Objectives
CLO 1- Use basic power system calculations and model power system elements.	
CLO 2- Apply Gauss-Seidel and Newton-Raphson techniques to solve load flow problems.	
CLO 3- Use symmetrical components theory to solve problems related to unbalanced conditions	
CLO 4- Develop expressions for symmetrical and asymmetrical faults and solve related problems including use of bus impedance methods.	
CLO 5- Explain the concept of power system dynamics and predict stability of synchronous machines using the equal area criteria	

Assessment Strategy:

Activity	**Weighting**	**Learning Outcomes**
Final Assessment, Test	30%	All CLOs
Quizzes & Homework Quiz 1 Quiz 2 Quiz 3	10%	All CLOs
Labs (1,2,3,4,5)	20%	All CLOs
Written Examination – Test 1	20%	CLO 1 & 2 Test 1
Written Examination - Test 2	20%	CLO 3 & 4 Test 2

- **Week 1**- Demonstrate ability to carry out calculations using complex power techniques quadrant operation. (LO1)
- **Week 2**- Discuss the per unit system in power system calculations and Model major types of components used in electrical power systems and describe the representation of power system elements using the one-line diagram. (LO1)
- **Week 3-** Show how to formulate circuit admittance and impedance matrices and use them to carry out network analysis. (LO1)
- **Week 4-** List the various types of buses used in load flow studies and Derive the general power flow equation. (LO2) – **Quiz I**
- **Week 5-** Apply the Gauss – Seidel method of solution for a simple network. (LO2)
- **Week 6-** Apply the Newton – Raphson method of solution for a two – bus system. (LO2)
- **Week 7-** Show how unbalanced systems are resolved into balanced positive, negative and zero sequence components. (LO2) Quiz II
- **Week 8-** Derive expressions for sequence voltages in terms of phase and line voltages and for phase voltages and currents in terms of sequence components. (LO2) **Midterm I/Quiz II**
- **Week 9-** Derive expressions for power in terms of symmetrical components. (LO2) –
- **Week 10**- Analyze properties of 3 - phase circuits with regard to sequence components of voltage and currents, and produce symmetrical components sequence networks for lines, generators and transformers. (LO3)
- **Week 11-** State the purpose and type of fault calculations and outline assumptions made when solving problems. Use the equivalent circuit of one source and one impedance to solve symmetrical faults problems. (LO3) – **Midterm II/Quiz III**
- **Week 12-** Convert the fault level of incoming supply to system reactance in series with a voltage source. Derive expressions and equivalent circuits for the following asymmetrical faults: (a) line to ground fault, (b) double line to ground fault, and (c) line to line fault.
- **Week 13-** Explain the effect of generator impedance and transformer connections on fault current. Use the bus impedance matrix methods to solve symmetrical and asymmetrical fault problems.
- **Week 14-** Define steady state, transient and dynamic stability and explain the stability limit. Identify situations in which steady state and transient state.
- **Week 15-** Derive and outline the swing equation concept. Explain the equal area criteria and show how to predict stability.
- **Week 16-** Use equal area criteria to assess under the following conditions: (a) sudden change in load, (b) change in transfer reactance due to switching, and (c) change in transfer reactance due to fault. Calculate the critical clearing angle during a fault and state methods to improve transient stability limit.
- **Week 17-** Final Exam Week