Kadi Sarva Vishwavidyalaya

Faculty of Engineering & Technology

Fourth Year Bachelor of Engineering (Electrical Branch)

With effect from: Academic Year 2020-21

Subject Code: EE701-N	Subject Title: **Interconnected Power System**

Course Objective:

- To address the concept behind Interconnected Power System.
- To impart knowledge of advancement in the field of power system with insight experimental approach.
- The course starts with a review of power systems stability and load flow analysis.
- To impart knowledge of Economic operation of power system & generator modeling.
- It provides students with intense training in research methods, advanced simulation tools and experimental techniques in power systems.

A. Teaching / Examination Scheme

Teaching scheme				Total Credit	Evaluation Scheme					Total Marks
L	T	P	Total		Theory		IE Marks	CIA Marks	Pract. Marks	
Hrs	Hrs	Hrs	Hrs		Hrs	Marks				
4	0	2	6	5	3	70	30	20	30	150

B. Outline of the Course:

1. **Introduction:**
   Structure of Power System, concept of Interconnection, Cascade Tripping, Islanding, Load dispatch center, Types of Excitation system and Importance of excitation in interconnected power system.
2. **Power system matrices :**
   Brief explanation of Graph theory, Primitive Network, Ybus formation methods, Singular transformation method, Direct method, Algorithm for formation of Zbus, Addition branch and link, Removal of elements, Numericals.
3. **Load flow studies**
   Introduction, Necessity of Load Flow studies, Static Load Flow Equations, Bus Classifications, Approximate method, Gauss-Seidel Method, Newton Raphson Method, Decoupled Load flow method, Fast Decoupled Load Flow Method, Comparison of different methods, Calculation of Line flows.

4. **Economic operation of power systems:**
   Generator operating cost, Economic operation of generators within thermal plant, optimal operation by co-ordination equation, Penalty factor, Derivation of transmission loss formula (Kron's method), Unit commitment problem solution by dynamic programming, Numericals.
5. **Frequency and voltage control methods:**
   Speed governing mechanism, Mathematical modeling, Adjustment of Governor characteristics, Single area control, Flat frequency control, Selective frequency control, Tie line load bias control, Methods of voltage control, Numericals.
6. **Power system stability:**
   Introduction, types of stability, stability limit, concept of load angle and infinite bus, Power angle curve, Swing equation, Solution of swing equation, Steady state stability analysis, Methods of improving Steady state stability , Transient stability analysis, step by step method, Methods of improving Transient stability, Equal area criteria, Numericals.

C. <u>Lesson Planning</u>

Sr. No.	Lectures Hours.	Weightage in % in Exam	Course Contents
1	6	10	**Introduction:** Structure of Power System, concept of Interconnection, Cascade Tripping, Islanding, Load dispatch center, Types of Excitation system.
2	8	15	**Power system matrices** Brief explanation of Graph theory, Primitive Network, Ybus formation methods, Singular transformation method, Direct method, Algorithm for formation of Zbus, Addition branch and link, Removal of elements, Numericals.
3	10	20	**Load flow studies** Introduction,Necessity of Load Flow studies,Static Load Flow Equations, Bus Classifications, Approximate method, Gauss-Seidel Method, Newton Raphson Method, Decoupled Load flow method, Fast Decoupled Load Flow Method, Comparison of different methods, Numericals.
4	8	15	**Economic operation of power systems** Generator operating cost, Economic operation of generators within thermal plant, Optimal operation by co-ordination equation, Penalty factor, Derivation of transmission loss formula (Kron's method), Unit commitment problem solution bydynamic programming, Numericals.

5	8	15	**Frequency and voltage control methods** Speed governing mechanism, Mathematical modelling, Adjustment of Governor characteristics, Single area control, Flat frequency control, Selective frequency control, Tie line load bias control, Methods of voltage control, Numericals.
6	12	25	**Power system stability** Introduction, types of stability, stability limit, concept of load angle and infinite bus, Power angle curve, Swing equation, Solution of swing equation, Steady state stability analysis, Methods of improving Steady state stability , Transient stability analysis, step by step method, Methods of improving Transient stability, Equal area criteria, Numericals.
	52	**100**	**Total**

Suggested List of Experiments:

1.	WRITE program for filtering out α, β and ϒ values from the given fuel cost function of three generators.
2.	WRITE program for displaying final summary of fuel cost functions from the details provided by the user.
3.	WRITE program that gives the optimal load division of two thermal plants.
4.	WRITE program for building Y_{BUS} matrix.
5.	WRITE program for assembly of Z_{BUS} matrix.
6.	WRITE program for power flow studies by Gauss Siedel method.
7.	WRITE program for power flow studies by Newton Raphson method.
8.	WRITE program for power flow studies by Fast Decoupled method.
9.	WRITE program for determining the transient stability when input power is suddenly increased.
10.	WRITE program for determining the transient stability when input power is suddenly decreased.
11.	WRITE program for Dynamic simulation of Single machine infinite bus.
12.	WRITE program for Dynamic simulation of three bus two machine system for transient stability for different type and location of fault.

D. <u>Term Work:</u>

1. WRITE Programming on Economic operation of power systems and Load flow studies.

2. Dynamic simulation of small power system with different operating points and cases.
3. Tutorials.

E. Instructional Method & Pedagogy

- At the start of course, the course delivery pattern, prerequisite of the subject will be discussed.
- Lecture may be conducted with the aid of multi-media projector, black board, OHP etc. & equal weightage should be given to all topics while teaching and conduction of all examinations.
- Attendance is compulsory in lectures, which may carries five marks in overall evaluation.
- One/Two internal exams may be conducted and total/average/best of the same may be converted to equivalent of 30 marks as a part of internal theory evaluation.
- Assignment based on course content will be given to the student for each unit/topic and will be evaluated at regular interval. It may carry an importance of ten marks in the overall internal evaluation.
- Surprise tests/Quizzes/Seminar/Tutorial may be conducted and having share of five marks in the overall internal evaluation.

F. Students Learning Outcomes

On successful completion of the course,

- Students will acquire the concept behind Interconnected Power System.
- Students will acquire the knowledge of load flow analysis and its necessity in power system.
- Student will learn different methods for load flow studies.
- Students will be able to know the effect of frequency and voltage in power system stability and various frequency and voltage control methods in power system.
- Students will be able to know the concept and analysis of transient and steady state stability and various methods to improve transient & steady state stability in power system.

G. Reference Books:

1. Modern Power System Analysis by D. P. Kothari &I. J. Nagrath, Tata- McGraw-Hill.
2. Power System Analysis by John J. Grainger & Jr. Stevenson, Mcgraw-Hill.
3. Electrical Power System Analysis, by Dr. Shivanagaraju& B.V Rami Reddy, University Science Press.
4. Power System Analysis by HadiSaadat, Tata-McGraw-Hill.
5. Electrical Power Systems by C. L. Wadhwa, New Age International.

H. Learning Resources:

1. www.nptel.iitm.ac.in MIT open courseware.