**Course Handout**

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| **Institute / College Name :** | Darbhanga College of Engineering | | |
| **Program Name** | **B.Tech Electrical** | | |
| **Course Code** | EEUG 031814 | | |
| **Course Name** | Power System Design | | |
| **Lecture / Tutorial (per week):** | 3/1(lab) | **Course Credits** | 3 |
| **Course Coordinator Name** | ABHISHEK SHARMA | | |

1. **Scope and Objectives of the Course**

This course is designed to equip students with necessary tools for designing and analyzing power system. This course introduces various design techniques that are used in practice for designing power system. This course provide opportunity for students to have hands on experience in designing and analyzing power system.

After competition of the course, students will be able to:

CO1: Understand working and operation of power system

CO2: Create computational models for analysis of power system

CO3: Analyze load flow, fault analysis and various problems related to power system

CO4: Select appropriate instruments and tools for designing power system

1. **Textbooks**

**TB1:** ‘Modern Power System Analysis’ by D.P. Kothari, I.J. Nagrath, Fourth Edition, Tata McGraw Hill publication

**TB2**: ‘Power System Analysis’ by John J. Grainger and William D. Stephenson Jr., McGraw Hill publication **Reference Books**

**RB1: ‘**Power System Analysis’ by Hadi Sadat, Tata McGraw Hill publication

**RB2: ‘**Electrical Energy System Theory: An Introduction’, by Ollie Elgard , Tata McGraw Hill publication

**Other readings and relevant websites**

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| S.No. | **Link of Journals, Magazines, websites and Research Papers** |
|  | <http://nptel.ac.in/courses/108107028/> |

1. **Lecture Plan**

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| --- | --- | --- | --- | --- | --- |
| **Lecture Number** | Date of Lecture | Topics | **Web Links for video lectures** | **Text Book / Reference Book / Other reading material** | **Page numbers of Text Book(s)** |
| 1-2 |  | Introduction |  | TB1, TB2 |  |
|  |  | Configuration of power system, representation of elements of power system, per unit system |  |  |  |
| 3-5 |  | **Reactance Diagram, Impedance Diagram** |  | TB1, TB2 |  |
|  |  | Representation of various elements like transformer, transmission lines etc. using reactance and impedance diagram | <https://www.youtube.com/watch?v=BYtY61hOiaw> |  |  |
| **Assignment I** | | | | | |
| 7-9 |  | **Load Flow Analysis** |  | TB1, TB2 |  |
|  |  | Load flow problem, Ybus, Formulation of Ybus, Gauss Seidal Method | <https://www.youtube.com/watch?v=BYtY61hOiaw> |  |  |
| **Problem Session 1** | | | | | |
| 10-12 |  | **Symmetrical Short Circuit analysis** |  | TB1, TB2 |  |
|  |  | Short circuit of a Synchronous machine on no load, Short circuit of  loaded synchronous machine, Thevenin's equivalent circuit approach for short circuit analysis |  |  |  |
| **Assignment 2** | | | | | |
| 13-16 |  | **Symmetrical Components** |  | TB1, TB2 |  |
|  |  | Transformation, phase shift in star-delta transformer, sequence Impedance and  sequence network of transmission line, Synchronous machine, Transformer and power system |  |  |  |
| **Problem Session 2** | | | | | |
| 17-20 |  | **Unsymmetrical Short Circuits** |  | TB1, TB2 |  |
|  |  | Symmetrical component analysis of unsymmetrical short Circuits, Single line to  ground fault, Double line to ground fault and line to line fault, |  |  |  |
| **Assignment 3** | | | | | |
| 21-23 |  | **Power system stability problem** |  | TB1, TB2 |  |
|  |  | Swing equation, System response to small disturbances, Power angle  equation and diagram |  |  |  |
| 24-26 |  | **Transient stability** |  | TB1, TB2 |  |
|  |  | Equal area criterion, Measures for improving transient stability |  |  |  |
| **Final Problem Session** | | | | | |

1. **Evaluation Scheme:**

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| Component 1 | Mid Semester Exam | 20 |
| Component 2 | Assignment, Class tests, Attendance | 10 |
| Component 3\*\* | End Term Examination\*\* | 70 |
|  | **Total** | **100** |

**\*\*** The End Term Comprehensive examination will be held at the end of semester. The mandatory requirement of 75% attendance in all theory classes is to be met for being eligible to appear in this component.

**SYLLABUS**

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| Topics | **No of lectures** | **Weightage** |
| **Per unit system representation**, reactance diagram, impedance diagram. | 5 | 11% |
| **Load flow Analysis**; Load flow problem, ybus, Formulation of problem, solution technique using Gauss seidel  method | 7 | 16% |
| **Symmetrical short circuits Analysis**; Short circuit of a Synchronous machine on no load, Short circuit of  loaded synchronous machine, Thevenin's equivalent circuit approach for short circuit analysis | 7 | 16% |
| **Symmetrical component**; Transformation, phase shift in star-delta transformer, sequence Impedance and  sequence network of transmission line, Synchronous machine, Transformer and power system. | 8 | 18% |
| **Unsymmetrical Short Circuits**; Symmetrical component analysis of unsymmetrical short Circuits, single line to  ground fault, Double line to ground fault and line to line fault. | 7 | 16% |
| **Power system stability problem**, Swing equation, System response to small disturbances, Power angle  equation and diagram | 6 | 13% |
| **Transient stability**, Equal area criterion, Measures for improving transient stability | 5 | 11% |

**This Document is approved by:**

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| --- | --- | --- |
| **Designation** | **Name** | **Signature** |
| Course Coordinator | Mr. Abhishek Sharma |  |
| H.O.D | Mr. Santosh Kr. Gupta |  |
| Principal | Dr. Aseem Kumar Thakur |  |
| Date |  |  |

**Evaluation and Examination Blue Print:**

Internal assessment is done through quiz tests, presentations, assignments and project work. Two sets of question papers are asked from each faculty and out of these two, without the knowledge of faculty, one question paper is chosen for the concerned examination. Examination rules and regulations are uploaded on the student’s portal. Evaluation is a very transparent process and the answer sheets of sessional tests, internal assessment assignments are returned back to the students.

The components of evaluations alongwith their weightage followed by the University is given below

Sessional Test 1 20%

Assignments/Quiz Tests/Seminars 10%

End term examination 70%

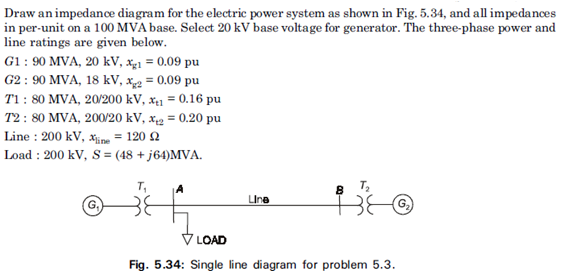
(From amongst the three sessional tests best of two are considered)

**ASSIGNMENT –I**

**Q.1 –** Explain the need of representing power system quantities in per unit system.

**Q.2-** When can the power system be represented in single line diagram? Draw the single line diagram for a power system containing three generators and loads.

**Q.3-** Derive expressions for per unit impedance of transformer on both side.

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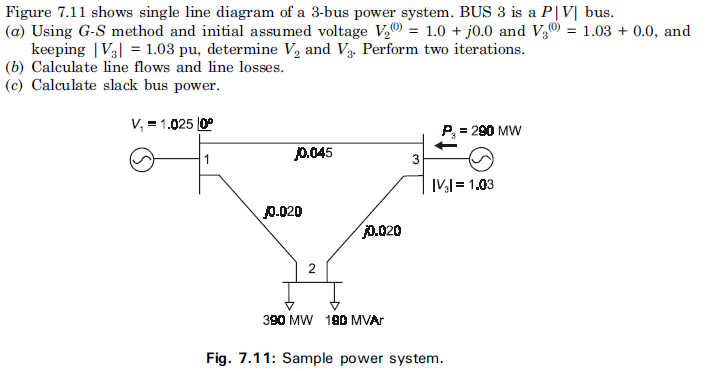
**Q. 4-**

**ASSIGNMENT –II**

**Q.1-** Derive the expression for power flow equations.

**Q.2-** What information we get from load flow analysis?

**Q.3-** Explain load flow analysis using Gauss-Seidal method.



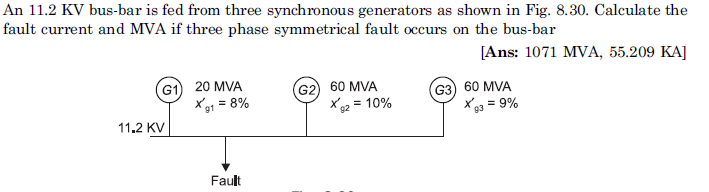
**Q. 4-**

**ASSIGNMENT –III**

**Q.1-** Explain different types of fault on power system with their percentage of occurance with reason.

**Q.2-** Write the Thevenin’s equivalent circuit approach for short circuit analysis.

**Q.3-** Derive the expression for short circuit MVA for synchronous machine.



**Q. 4-**

**Tutorial 1**

**Q.1** Which of the following transmission system will be most economical and why?

a) Three Phase System b) Six Phase System c) Twelve Phase System d) Single Phase System

**Q.2** Derive formulae for instantaneous power in terms of voltage and current and relate it to active and reactive power.

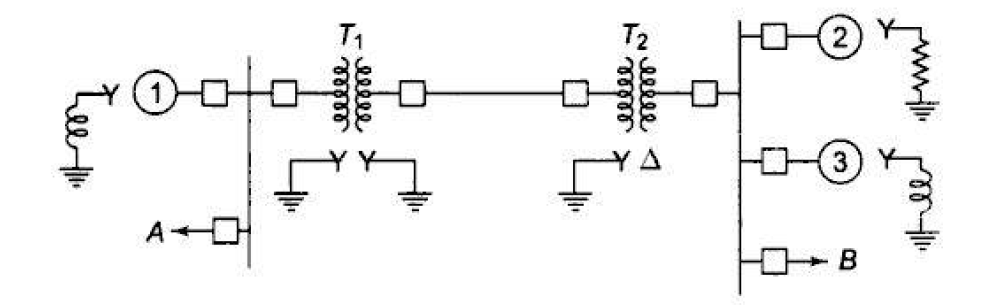
Q.3 Calculate approximate active power drawn by a motor driving an electric pump, from the source if the pump can fill the tank at a height of 10 meters with 10 Kg of water in 10 sec.(Neglect losses)

**Tutorial 2**

Q.1 Give the formula to calculate base current, Ib and base impedance of a three phase system.

Q.2 Derive expression for load impedance (per phase) if the power absorbed by the load and the voltage across it is given.

Q.3 *Draw per unit impedance diagram for the power system form its one line diagram given below in fig. 1 and the corresponding data is also given below.*



***Fig. 1 One-line diagram of power system***

