# Walchand College of Engineering, Sangli

*(Government Aided Autonomous Institute)*

## Course Contents (Syllabus) for

## Second Year M. Tech.
## Electrical
## (Power Systems Engineering)
## Sem - III to IV

**AY 2020-21**

| Title of the Course: Dissertation Phase I 3PS690, Dissertation Phase II 3PS691 , Dissertation Phase II 3PS692 | L | T | P | Cr |
|---|---|---|---|---|
| | -- | -- | 24 | 10 |

**Pre-Requisite Courses:-**

**Textbooks: -**

**References:**

Proceedings of Reputed National and International journals in Power Systems (Electrical Engineering) [a. IEEE Transactions on - Power Delivery, Power Apparatus and Systems, Power Electronics, Circuits and systems, Control systems technology, Automatic Control etc. b. IEEE magazines/ newsletters/ proceedings on- Power and Energy magazine, Industrial electronics magazine, Control systems magazine etc. c. IET Proceedings/ journals/ magazines on - Power Engineer magazine, Electrical power applications, Renewable power generation, Generation, transmission and distribution etc. d. Elsevier journals and magazines on- Electrical and Electronics Engineering – Power systems, Electrical power systems research, Electrical power, Energy etc. e. Electrical power components and systems journal, f. Cogeneration and distributed generation journal g. Journal of Institution of Engineers India- Electrical Engineering h. The Journal of the Institute of Electrical Engineers of Japan, i. Circuits, Systems & Signal Processing –Springer, j. Energy Efficiency – Springer k. Mathematics of Control, Signals, and Systems – Springer l. Engineering with Computers · An International Journal for Simulation-Based Engineering – Springer m. Journal of Control Theory and Applications –Springer n. Journal of Dynamical and Control Systems – Springer o. Journal of Real-Time Image Processing – Springer] Proceedings of Reputed National and International Conferences
[a. National Power Systems Conference b. IEEE Power Engineering Society Conference c. Other Conferences sponsored by IEEE/ IET/ Elsevier.]

**Course Objectives :**

The M. Tech. Dissertation is aimed at training the students to analyze independently any problem in the field of Electrical Engineering or interdisciplinary. The Dissertation may be analytical, computational, experimental or a combination of three. The Dissertation report is expected to show clarity of thoughts and expression, critical appreciation of the existing literature and analytical, experimental, computational aptitude. The student progress of the dissertation work shall be evaluated in stage I and II in semester III and in stage III and IV in semester IV.

**Course Learning Outcomes:**

| CO | After the completion of the course the student should be able to | Bloom's Cognitive level | Bloom's Cognitive Descriptor |
|---|---|---|---|
| CO1 | **Defend** the objectives of the dissertation by grasping and **analyzing** through an extensive literature review in the area of study. | 2<br>4<br>5 | Understand<br>Analyze<br>Evaluate |
| CO2 | **Formulate** the methodology and **Execute** the study through conduct of analytical/Experimental work to achieve the objectives. | 4<br>6 | Apply<br>Create |
| CO3 | **Analyze, interpret and critique** the findings of the study. | 3<br>4<br>5 | Apply<br>Analyze<br>Evaluate |
| CO4 | **Defend** the outcomes of the dissertation through self-learning and **justify** the project work as per appropriate standards of documentation and presentation. | 5 | Evaluate |

**CO-PO Mapping :**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | 2 | |
| **CO2** | 2 | | 3 | 3 | | |
| **CO3** | | | | 2 | 1 | 2 |
| **CO4** | | 3 | | | 2 | 2 |

**Assessments :**

**Teacher Assessment:**

In Semester Evaluation (ISE) and End Semester Evaluation (ESE)

| Assessment | Credits | Marks |
|---|---|---|
| Dissertation Phase I ISE | 4 | 100 |
| Dissertation Phase II ISE | 2 | 100 |
| Dissertation Phase II ESE | 4 | 100 |

**ISE for dissertation phase I** is based on the efforts by the student for synopsis preparation. It shall be evaluated using the parameters extent of literature review, scope defined, objectives, and fundamental concepts, quality of presentation, and interaction during presentation, effort/work done, quality of report and interaction with guide.

**ISE for dissertation phase II** is based on the progress made during the semester for the objectives defined in the synopsis and the report submitted by the students. It shall be evaluated through progress seminar(s) at the end of the semester. The parameters for evaluation include extent of work done, results and discussion/publication efforts, quality of presentation, quality of report, interaction during presentation and interaction with guide.

ISE shall be conducted by Dissertation Evaluation Committee (DEC).

**ESE for dissertation phase II** shall be conducted at the end of semester by a duly constituted examination panel composed of Chairman, internal examiner (guide) and external examiner.

**ISE for dissertation phase III** is based on the work done by the student during fourth semester. It shall be evaluated using the parameters extent of work done after phase II, quality of presentation, interaction during presentation, and interaction with guide.

**ISE for dissertation phase IV** is based on the work done during the semester and the report submitted by the students. It shall be evaluated through progress seminar(s) at the end of the semester. The parameters for evaluation include extent of work done, results and discussion/publication efforts, quality of presentation, quality of report, interaction during presentation and interaction with guide.

ISE shall be conducted by Dissertation Evaluation Committee (DEC).

**ESE for dissertation phase IV** shall be conducted at the end of semester by a duly constituted examination panel composed of Chairman, internal examiner (guide) and external examiner.

**Course Contents:**

The third semester is completely devoted to dissertation work which is defined based on the interest of the students to specialize in a particular area.

Student is expected to carry out independent research work on the chosen topic. In this semester it is expected that the student has carried out substantial research work including exhaustive literature survey, formulation of the research problem, development/fabrication of experimental set-up (if any/required) and testing, and analysis of initial results thus obtained. In fourth semester, the student continues his/her dissertation work. It is expected that the student has completed most of the experimental/computation works and analyzed the results so obtained as proposed in the synopsis. The work should be completed in all respects in this semester. The student is required to submit the dissertation work in the form of report as per

| |
|---|
| the institute rule. |

# Professional Elective (Theory)

| **Title of the Course: Modern Power Electronics** | L | T | P | Cr |
|---|---|---|---|---|
| **Course Code: 3PS611** | 3 | -- | -- | 3 |

**Pre-Requisite Courses:** Power Electronics

**Textbooks:**

1. M. H. Rashid, "Power Electronics: circuits devices and applications", Pearson Education, Third edition.

**References:**

1. B. K. Bose, "Modern Power Electronics and AC drives", PHIPL, New Delhi.
2. M. B. Patil, V. Ramayanan and V. T. Ranganathan, "Simulation of Power Electronics circuits", Narosa publication.
3. Remus Teodorescu, Marco Liserre and Pedro Rodrigues, "Grid- Converters for Photovoltaic and Wind Power Converters, A john wiley and sons Ltd., first edition 2011.
4. IEEE Transaction papers.

**Course Objectives :**

1. It is aimed to impart skills of analysis for different types of advanced converters and shunt active power filters.
2. Make the students acquainted with control strategies of different types of advanced converters and shunt active power filters.
3. To make aware of research avenues in the field of power electronics.

**Course Learning Outcomes:**

| **CO** | **After the completion of the course the student will be able to** | Bloom's Cognitive | |
|---|---|---|---|
| | | level | Descriptor |
| **CO1** | **Interpret** configuration and working of various Power Electronic converters. | 3 | Applying |
| **CO2** | **Analyze** various Power Electronic converters and systems. | 4 | Analyzing |
| **CO3** | **Evaluate** various power electronic systems using power electronic converters. | 5 | Evaluating |

**CO-PO Mapping :**

| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
|---|---|---|---|---|---|---|
| **CO1** | | | 1 | | | |
| **CO2** | | | | 1 | | |
| **CO3** | | | | 2 | | 1 |

**Assessment:**

**Teacher Assessment:**

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

| Assessment | Marks |
|---|---|
| ISE 1 | 10 |
| MSE | 30 |
| ISE 2 | 10 |
| ESE | 50 |

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group

discussion. [One assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

**Course Contents:**

| **Module 1: PWM rectifiers** | **Hrs.** |
|---|---|
| Advantages & disadvantages of three phase thyristor converter, PWM converters working, types, Control of PWM rectifiers, analysis and application. | **6** |
| **Module 2: Multilevel inverters** | **Hrs.** |
| Three phase two level inverter, Multilevel inverter, Types: Diode clamp multilevel inverter, flying capacitor multilevel inverter, cascaded multilevel inverter, applications of multilevel inverters, comparison of multilevel inverter. Control method: sinusoidal PWM, selective harmonic elimination, carrier PWM, space vector PWM. | **6** |
| **Module 3: Resonant pulse inverters** | **Hrs.** |
| Series resonant inverter with unidirectional and bi-directional switches, parallel resonant inverters, voltage control of resonant inverters, zero current and zero voltage switching resonant converters, two-quadrant ZVS resonant converters, resonant DC link inverters. | **8** |
| **Module 4: Photovoltaic Inverters** | **Hrs.** |
| Photovoltaic Inverters structures derived from H bridge topology such as H5 inverter, Heric inverter, REFU inverter, full bridge inverter with DC bypass, inverter structures derived from NPC topology such as neutral point clamped half bridge inverter, conergy NPC inverter, three phase PV inverter. | **6** |
| **Module 5: Matrix Converters and Z source inverters** | **Hrs.** |
| Topology, working and control methods of Matrix converters, Various circuit topologies and control of Z source inverter, Application of Z source in induction motor control | **6** |
| **Module 6: Active power filters** | **Hrs.** |
| Power Quality Issues due to power Electronics, Introduction to active power filter, types of active power filters overall control of shunt active power filter, harmonic compensation & reactive power compensation. | **6** |

**Module wise Measurable Students Learning Outcomes:**

After completion of the course students will be able to:

1. Demonstrate working of PWM converters, their advantages & applications.
2. Interpret control the multilevel inverters.
3. Analyze resonant converters.
4. Analyze photovoltaic inverters.
5. Analysis of z-source inverter.
6. Verify performance of active filter for non-linear load.

| **Title of the Course: HVDC Transmission** | L | T | P | Cr |
|---|---|---|---|---|
| **Course Code: 3PS612** | 3 | -- | -- | 3 |

**Pre-Requisite Courses:** Power Electronics**,** Power System Engineering

**Textbooks:**

1. K.R. Padiyar, "H.V.D.C. Power Transmission", Wiley Eastern New Delhi.
2. E.W. Kimbark, "Direct Current Transmission", Win publisher.

**References:**

1. J. Arrillaga, "H.V.D.C. Transmission", Peter limited.
2. S.Rao, "E.H.V.A.C. & H.V.D.C. Transmission", Khanna Publishers.

**Course Objectives :**

1. It is aimed to provide detailed knowledge of controlled converters for HVDC transmission system.
2. It demonstrate use of different control and protection methods in HVDC transmission system.
3. It provides recent trends in HVDC transmission system.

**Course Learning Outcomes:**

| **CO** | **After the completion of the course the student will be able to** | Bloom's Cognitive | |
|---|---|---|---|
| | | level | Descriptor |
| **CO1** | **Investigate** appropriate control and protection schemes for HVDC transmission system. | 3 | Applying |
| **CO2** | **Interpret** performance of converter for HVDC transmission systems. | 4 | Analyzing |
| **CO3** | **Appraise** recent trends in HVDC transmission systems. | 5 | Evaluating |

**CO-PO Mapping :**

| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
|---|---|---|---|---|---|---|
| **CO1** | | | | 3 | | |
| **CO2** | | | 3 | | | |
| **CO3** | | | | | | 2 |

**Assessment:**

**Teacher Assessment:**

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

| Assessment | Marks |
|---|---|
| ISE 1 | 10 |
| MSE | 30 |
| ISE 2 | 10 |
| ESE | 50 |

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group discussion. [One assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

**Course Contents:**

| **Module 1: Introduction to HVDC Transmission Technology** | **Hrs.** |
|---|---|
| Comparison of EHVAC and HVDC Transmission, types of HVDC transmission systems, | **6** |

| | |
|---|---|
| components of HVDC transmission system. | |
| **Module 2: Analysis of HVDC converter** | **Hrs.** |
| Different modes of valve operation, o/p voltage waveforms and D C voltage in rectification, and inverter operation, valve voltages, equivalent electrical circuit, converter charts. | **6** |
| **Module 3: HVDCTS control features** | **Hrs.** |
| Control modes, control schemes and their comparisons, energization and de-energization of bridges, starting and stopping of D C link. | **6** |
| **Module 4: Faults and over-voltages** | **Hrs.** |
| Converter mal-operations, commutation failure, over-voltages in HVDCTS, protection of converters, D C reactor and damper circuits. | **6** |
| **Module 5: Harmonics and their suppression in HVDCTS** | **Hrs.** |
| Harmonic analysis, filter design, minimum cost tuned A C filters, reactive power requirements. | **6** |
| **Module 6: Multi terminal HVDCTS** | **Hrs.** |
| Series and parallel MTDCTS, their control, introduction to HVDC light, recent trends in HVDCTS. | **6** |

**Module wise Measurable Students Learning Outcomes :**

After completion of the course students will be able to:

1. Explain need of HVDC and layout
2. Analyze HVDC converters, and derive its equivalent circuit. They will be able to prepare and read converter charts of HVDCTS.
3. Interpret different control modes of HVDCTS, and will be able to compare these to control schemes. They will be able to explain energization and de-energization and starting and stopping procedures for HVDC links.
4. Study various faults and causes of over-voltages. They will be able to suggest various methods to protect HVDCTS.
5. Assess causes of harmonics and will be able to design cost effective filter for harmonics suppression which will meet reactive power requirements of the system as well.
6. Classify different types of Multi terminal HVDC system and compare them. They will be able to understand various control aspects of MTDC system

| **Title of the Course: High Voltage Engineering** | L | T | P | Cr |
|---|---|---|---|---|
| **Course Code: 3PS613** | 3 | -- | -- | 3 |

**Pre-Requisite Courses:** Power System Engineering

**Textbooks:**

1. E. Kuffel & W.S. Zaengl, '*High Voltage Engineering Fundamentals*' Pergamon Press, 1992
2. M.S. Naidu & V. Kamaraju '*High Voltage Engineering*', 4th Edition Tata Mc-Graw Hill, 2011

**References:**

1. C.L. Wadhwa, '*High Voltage Engineering'* New Age, 2007.
2. E. Kuffel & Abdullah '*High Voltage Engineering',* 1st Edition, PPO, 1981.

**Course Objectives:**

1. The course covers the breakdown mechanisms in gaseous, liquid and solid insulation.
2. Methods of generation and measurement of high voltage, impulse voltage and impulse current are also covered.
3. This course lays a foundation for higher studies in high voltage engineering

**Course Learning Outcomes:**

| **CO** | **After the completion of the course the student should be able to** | Bloom's Cognitive | |
|---|---|---|---|
| | | level | Descriptor |
| **CO1** | **Summarize** breakdown mechanisms in gaseous, liquid and solid insulations. | 2 | Understanding |
| **CO2** | **Analyze** the HV generation equipment and their application. | 3 & 4 | Analyzing & applying |
| **CO3** | **Design and construct** a simple HV gadget/ model. | 6 | Creating |

**CO-PO Mapping:**

| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
|---|---|---|---|---|---|---|
| **CO1** | | | 2 | | | |
| **CO2** | | | | 3 | | |
| **CO3** | 2 | 2 | | | | |

**Assessments :**

**Teacher Assessment:**

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

| Assessment | Marks |
|---|---|
| ISE 1 | 10 |
| MSE | 30 |
| ISE 2 | 10 |
| ESE | 50 |

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

**Course Contents:**

| **Module 1: Breakdown In Gaseous Medium** | **Hrs.** |
|---|---|
| Townsend mechanism of breakdown in gases, streamer (kanal) mechanism of breakdown in gases, derivation of breakdown criterion for Townsend and streamer mechanisms.<br>Paschen's law for breakdown voltage in gases, effect of pressure and gap distance on breakdown voltage. | **6** |
| **Module 2: Breakdown In Liquid and Solid Insulation** | **Hrs.** |
| Comparison of pure and commercial liquids for insulation, breakdown in pure liquids, effect of hydrostatic pressure on breakdown strength.<br>Breakdown in commercial liquids - suspended particle theory, cavitation and bubble theory, thermal breakdown, stressed oil volume theory.<br>Types of breakdown mechanisms in solids - intrinsic, electromechanical, treeing and tracking, thermal breakdown, electrochemical, breakdown due to internal discharges. Breakdown in composite dielectrics, applications of solid dielectrics like paper, mica, glass and ceramics. | **6** |
| **Module 3: Generation Of High Voltages** | **Hrs.** |
| Generation of high D.C. voltages by rectifiers, voltage doubler and multiplier circuits, electrostatic machines - Van de Graaff generator, electrostatic generator.<br>Generation of high A.C. voltages by cascade transformer set, resonant transformer, Tesla coil for generation of high frequency A.C. voltage. | **7** |
| **Module 4: Generation Of Impulse Voltage and Current** | **Hrs.** |
| Standard impulse wave shape, analysis of model and commercial impulse generation circuits, wave shape control, Marx circuit, tripping and control of impulse generation.<br>Generation of switching surges, generation of impulse current. | **7** |
| **Module 5: Measurement Of High Voltage and Current** | **Hrs.** |
| Peak voltage measurement by Chubb - Fortescue method, spark gaps, sphere gap, uniform field gap, rod gap, electrostatic voltmeter, measurement of high voltage by an ammeter in series with high impedance, use of rectifier and voltage divider.<br>Measurement of high A.C., D.C. and impulse currents by resistive shunts- Hall generator, current transformer with electro-optical signal converter, squirrel-cage shunt, Rogowski coil. | **8** |
| **Module 6: High Voltage Testing and Partial Discharges** | **Hrs.** |
| High voltage testing of - insulators, bushings, circuit breakers, cables, transformers, lightning arrestors and power capacitors.<br>Phenomenon of partial discharges (PD), internal and surface discharges, effects of PD, equivalent circuit of PD phenomenon, measurement of apparent charge.<br>PD detection - straight detection method, wide band and narrow band detection circuits. Bridge detection method, calibration of PD detectors. | **6** |

**Module wise Measurable Students Learning Outcomes:**

After completion of the course students will be able to:

**Module 1:CO1-** Explain and compute the breakdown strength of gas-filled insulation systems with simple geometries.

**Module 2:CO1-** Summarize the breakdown mechanisms of pure & contaminated liquids and solids.

**Module 3:CO2 & 3-** Design & demonstrate the principles behind generating DC and AC at high voltages.

**Module 4:CO2 & 3-** Differentiate various methods of high impulse voltages & current generation &

design a simple impulse voltage generator.
**Module 5:CO2-** Analyse various techniques for measurement of high voltages & currents.
**Module 6:CO1-** Distinguish methods of testing for HV equipment.

# EVEN Semester

# Professional Core (Lab) Courses

| Title of the Course: Dissertation Phase III 3PS693, Dissertation Phase IV 3PS694 and Dissertation Phase IV 3PS695 | L | T | P | Cr |
|---|---|---|---|---|
| | -- | -- | 32 | 16 |

**Pre-Requisite Courses:-**

**Textbooks: -**

**References:**

Proceedings of Reputed National and International journals in Power Systems (Electrical Engineering) [a. IEEE Transactions on - Power Delivery, Power Apparatus and Systems, Power Electronics, Circuits and systems, Control systems technology, Automatic Control etc. b. IEEE magazines/ newsletters/ proceedings on- Power and Energy magazine, Industrial electronics magazine, Control systems magazine etc. c. IET Proceedings/ journals/ magazines on - Power Engineer magazine, Electrical power applications, Renewable power generation, Generation, transmission and distribution etc. d. Elsevier journals and magazines on- Electrical and Electronics Engineering – Power systems, Electrical power systems research, Electrical power, Energy etc. e. Electrical power components and systems journal, f. Cogeneration and distributed generation journal g. Journal of Institution of Engineers India- Electrical Engineering h. The Journal of the Institute of Electrical Engineers of Japan, i. Circuits, Systems & Signal Processing –Springer, j. Energy Efficiency – Springer k. Mathematics of Control, Signals, and Systems – Springer l. Engineering with Computers · An International Journal for Simulation-Based Engineering – Springer m. Journal of Control Theory and Applications –Springer n. Journal of Dynamical and Control Systems – Springer o. Journal of Real-Time Image Processing – Springer] Proceedings of Reputed National and International Conferences
[a. National Power Systems Conference b. IEEE Power Engineering Society Conference c. Other Conferences sponsored by IEEE/ IET/ Elsevier.]

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The M. Tech. Dissertation is aimed at training the students to analyze independently any problem in the field of Electrical Engineering or interdisciplinary. The Dissertation may be analytical, computational, experimental or a combination of three. The Dissertation report is expected to show clarity of thoughts and expression, critical appreciation of the existing literature and analytical, experimental, computational aptitude. The student progress of the dissertation work shall be evaluated in stage I and II in semester III and in stage III and IV in semester IV.

**Course Learning Outcomes:**

| CO | After the completion of the course the student should be able to | Bloom's Cognitive level | Bloom's Cognitive Descriptor |
|---|---|---|---|
| **CO1** | **Defend** the objectives of the dissertation by grasping and **analyzing** through an extensive literature review in the area of study. | 2<br>4<br>5 | Understand<br>Analyze<br>Evaluate |
| **CO2** | **Formulate** the methodology and **Execute** the study through conduct of analytical/Experimental work to achieve the objectives. | 4<br>6 | Apply<br>Create |
| **CO3** | **Analyze, interpret and critique** the findings of the study. | 3<br>4<br>5 | Apply<br>Analyze<br>Evaluate |
| **CO4** | **Defend** the outcomes of the dissertation through self-learning and **justify** the project work as per appropriate standards of documentation and presentation. | 5 | Evaluate |

**CO-PO Mapping :**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | 2 | |
| **CO2** | 2 | | 3 | 3 | | |
| **CO3** | | | | 2 | 1 | 2 |
| **CO4** | | 3 | | | 2 | 2 |

**Assessments :**

**Teacher Assessment:**

In Semester Evaluation (ISE) and End Semester Evaluation (ESE)

| Assessment | Credits | Marks |
|---|---|---|
| Dissertation Phase III ISE | 4 | 100 |
| Dissertation Phase IV ISE | 4 | 100 |
| Dissertation Phase IV ESE | 8 | 100 |

**ISE for dissertation phase I** is based on the efforts by the student for synopsis preparation. It shall be evaluated using the parameters extent of literature review, scope defined, objectives, and fundamental concepts, quality of presentation, and interaction during presentation, effort/work done, quality of report and interaction with guide.

**ISE for dissertation phase II** is based on the progress made during the semester for the objectives defined in the synopsis and the report submitted by the students. It shall be evaluated through progress seminar(s) at the end of the semester. The parameters for evaluation include extent of work done, results and discussion/publication efforts, quality of presentation, quality of report, interaction during presentation and interaction with guide.

ISE shall be conducted by Dissertation Evaluation Committee (DEC).

**ESE for dissertation phase II** shall be conducted at the end of semester by a duly constituted examination panel composed of Chairman, internal examiner (guide) and external examiner.

**ISE for dissertation phase III** is based on the work done by the student during fourth semester. It shall be evaluated using the parameters extent of work done after phase II, quality of presentation, interaction during presentation, and interaction with guide.

**ISE for dissertation phase IV** is based on the work done during the semester and the report submitted by the students. It shall be evaluated through progress seminar(s) at the end of the semester. The parameters for evaluation include extent of work done, results and discussion/publication efforts, quality of presentation, quality of report, interaction during presentation and interaction with guide.

ISE shall be conducted by Dissertation Evaluation Committee (DEC).

**ESE for dissertation phase IV** shall be conducted at the end of semester by a duly constituted examination panel composed of Chairman, internal examiner (guide) and external examiner.

**Course Contents:**

The third semester is completely devoted to dissertation work which is defined based on the interest of the students to specialize in a particular area.

Student is expected to carry out independent research work on the chosen topic. In this semester it is expected that the student has carried out substantial research work including exhaustive literature survey, formulation of the research problem, development/fabrication of experimental set-up (if any/required) and testing, and analysis of initial results thus obtained. In fourth semester, the student continues his/her dissertation work. It is expected that the student has completed most of the experimental/computation works and analyzed the results so obtained as proposed in the synopsis. The work should be completed in all respects in this semester. The student is required to submit the dissertation work in the form of report as per

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