# Walchand College of Engineering, Sangli

*(Government Aided Autonomous Institute)*

## Course Contents (Syllabus) for

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

**AY 2020-21**

| Title of the Course: Dissertation Phase I, II (ISE) and II (ESE) 3CS690, 3CS691 and 3CS692 | L | T | P | Cr |
|---|---|---|---|---|
| | -- | -- | 20 | 10 |

**Pre-Requisite Courses:-**

**Textbooks: -**

**References:**

Proceedings of Reputed National and International journals in Control Systems (Electrical Engineering)

[a. IEEE Transactions on – Automatic control systems, Power Electronics, Circuits and systems, Control systems technology, Automatic Control etc. b. IEEE magazines/ newsletters/ proceedings on- Control systems, Industrial electronics magazine, etc. c. IET Proceedings/ journals/ magazines on – Control Theory and Control Systems etc. d. Elsevier journals and magazines on- Electrical and Electronics Engineering, Circuits and systems, Advance process control, Dynamics and control etc. e. Journal of Institution of Engineers India- Electrical Engineering f. The Journal of the Institute of Electrical Engineers of Japan, g. Circuits, Systems & Signal Processing –Springer, h. Energy Efficiency – Springer i. Mathematics of Control, Signals, and Systems – Springer j. Soft Computing– Springer k. An International Journal for Simulation-Based Engineering – Springer l. Journal of Control Theory and Applications –Springer m. Journal of Dynamical and Control Systems – Springer

Proceedings of Reputed International Conferences organized by IFAC, IEEE in association with IITs and NITs, Elsevier and Springer conferences and IET conferences.

**Course Objectives :**

The M. Tech. Dissertation is aimed at training the students to analyze independently any problem in the field of Electrical Control Systems Engineering and applications of control theory. 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 |
| 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 Departmental Post-Graduate Committee (DPGC).

**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.

**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) Courses

| **Title of the Course: Modern Power Electronics** | L | T | P | Cr |
|---|---|---|---|---|
| **Course Code: 3CS611** | 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: Robotics and AI** | L | T | P | Cr |
|---|---|---|---|---|
| **Course Code: 3CS612** | 3 | -- | -- | 3 |

**Pre-Requisite Courses:** Electrical Machines, Instrumentation, Control System Engineering

**Textbooks:**

1. Robotics: Fundamental Concepts and Analysis by Ashitava Ghosal, Oxford University Press, 2nd Edition, 2008.
2. Robotics and Control by R.Mittle and I Nagrath, MGH Publications, 2017.

**References:**

1. Introduction to Robotics: Mechanics and Control, by Craig, 3rd Ed.Oxford University Press, 2008.

**Course Objectives :**

1. This course provides the basics of robot control.
2. It provides the methodology of modeling and control the robot.
3. It also provides the design of various types of robot controllers.

**Course Learning Outcomes:**

| **CO** | **After the completion of the course the student will be able to** | Bloom's Cognitive | |
|---|---|---|---|
| | | level | Descriptor |
| **CO1** | **Analyze** various models of robots and their dynamics. | 4 | Analyzing |
| **CO2** | **Analyze** problems associated with open loop and closed loop robot control system. | 4 | Analyzing |
| **CO3** | **Design** various conventional and advanced controllers for robotics. | 6 | Creating |

**CO-PO Mapping :**

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

**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.

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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 with 70-80% weightage for course content (normally last three modules) covered after MSE.

**Course Contents:**

| **Module 1: Introduction** | **Hrs.** |
|---|---|
| Introduction -- brief history, types, classification and usage Position and orientation of a rigid body, Homogeneous transformations, Representation of joints, link representation using D-H | **6** |

| | |
|---|---|
| parameters, Examples of D-H parameters and link transforms. | |
| **Module 2: Elements of robots -- joints, links, actuators, and sensors** | **Hrs.** |
| Different kinds of actuators – stepper, DC servo and brushless motors, model of a DC servo motor. Types of transmissions, Purpose of sensors, internal and external sensors, common sensors – encoders, tachometers, strain gauge based force-torque sensors, proximity and distance measuring sensors, and vision. | **6** |
| **Module 3: Kinematics of robots** | **Hrs.** |
| Introduction, Direct and inverse kinematics problems, Examples of kinematics of common serial manipulators, workspace of a serial robot, Inverse kinematics of constrained and redundant robots. Degrees-of-freedom of parallel mechanisms and manipulators, Active and passive joints, Constraint and loop-closure equations, Direct kinematics problem, Mobility of parallel manipulators, Closed-from and numerical solution, Inverse kinematics of parallel manipulators and mechanisms. | **6** |
| **Module 4: Velocity and statics of robot manipulators** | **Hrs.** |
| Linear and angular velocity of links, Velocity propagation, Manipulator Jacobians for serial and parallel manipulators, Velocity ellipse and ellipsoids, Singularity analysis for serial and parallel manipulators, Mass and inertia of links, Lagrangian formulation for equations of motion for serial and parallel manipulators. | **6** |
| **Module 5: Motion planning and control** | **Hrs.** |
| Joint and Cartesian space trajectory planning and generation, Classical control concepts using the example of control of a single link, Independent joint PID control, Control of a multi-link manipulator, Non-linear model based control schemes, Simulation and experimental case studies on serial and parallel manipulators, Control of constrained manipulators, Cartesian control, Force control and hybrid position/force control, Advanced topics in non-linear control of manipulators. | **6** |
| **Module 6: AI in Robotics** | **Hrs.** |
| Models of flexible links and joints, Kinematic modeling of multi-link flexible robots, Dynamics and control of flexible link manipulators. Advanced control using AI techniques, Fuzzy control, Neural control, Adaptive control and implementation issues. | **6** |

**Module wise Measurable Students Learning Outcomes :** After the completion of the course the student will be able to:

1. Describe model the Robot Control system.
2. Evaluate performance of robot system by conventional techniques.
3. Analyze the dynamics of robot process.
4. Analyze the kinematics of robot process.
5. Analyze the AI based controllers for robot control
6. Design advance digital controller based on model of the process.

**After the completion of the course the student should be able to:**

This course is designed to facilitate students from different programs to understand the basics and advanced topics of robotics and AI.

# EVEN Semester

# Professional Core (Lab) Courses

| Title of the Course: Dissertation Phase III, IV(ISE) and IV (ESE) 3CS693, 3CS694 and 3CS695 | L | T | P | Cr |
|---|---|---|---|---|
| | -- | -- | 32 | 16 |

**Pre-Requisite Courses:-**

**Textbooks: -**

**References:**

Proceedings of Reputed National and International journals in Control Systems (Electrical Engineering)

[a. IEEE Transactions on – Automatic control systems, Power Electronics, Circuits and systems, Control systems technology, Automatic Control etc. b. IEEE magazines/ newsletters/ proceedings on- Control systems, Industrial electronics magazine, etc. c. IET Proceedings/ journals/ magazines on – Control Theory and Control Systems etc. d. Elsevier journals and magazines on- Electrical and Electronics Engineering, Circuits and systems, Advance process control, Dynamics and control etc. e. Journal of Institution of Engineers India- Electrical Engineering f. The Journal of the Institute of Electrical Engineers of Japan, g. Circuits, Systems & Signal Processing –Springer, h. Energy Efficiency – Springer i. Mathematics of Control, Signals, and Systems – Springer j. Soft Computing– Springer k. An International Journal for Simulation-Based Engineering – Springer l. Journal of Control Theory and Applications –Springer m. Journal of Dynamical and Control Systems – Springer

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**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 |
| Dissertation Phase III ISE | 4 | 100 |
| Dissertation Phase IV ISE | 4 | 100 |
| Dissertation Phase IV ESE | 8 | 100 |

**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 Departmental Post-Graduate Committee (DPGC).

**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.

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