Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information	
Programme	M. Tech. (Control System Engineering)
Class, Semester	Second Year M. Tech., Sem III
Course Code	5CS601
Course Name	Legal, Financial aspects of industrial project
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	2 Hrs/Week	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-				
Interaction	-	**Credits: 2**			

Course Objectives	
1	To identify and analyze the relevant legal issues involved in Industrial Project and criminal matters affecting business.
2	To understand theories of value, risk and return, capital investment decisions, wages and working hours, insurance schemes, labour laws.
3	To become familiar with intellectual property in cyber space and different cyber laws.

Course Outcomes (CO) with Bloom's Taxonomy Level At the end of the course, students will be able to,		
CO1	To understand the terms involved and laws applicable for an Industrial Project.	Understand
CO2	To get acquainted with investments, taxes and employee schemes.	Apply
CO3	To be familiar with Cyber laws applicable for cyber crimes.	Apply

Module	**Module Contents**	**Hours**
I	**Economic Decision Making** Introduction, Mathematics of Time Value of Money: Compound Interest, Cash Flow Diagram, Uniform Annual Series, Irregular Cash Flows, Cost Comparison: Present Worth Analysis, Annual Cost Analysis, Capitalized Cost Analysis	4
II	**Taxes and Profitability** Taxes, Profitability of Investments: Rate of Return, Payback Period, Net Present Worth, Internal Rate of Return, Inflation, Sensitivity and Break-Even Analysis, Uncertainty in Economic Analysis	4
III	**Factories Act, 1948** Health, Safety, Provisions relating to Hazardous Processes, Welfare, Working Hours of Adults, Employment of young	4

	persons, Annual Leave with wages. The Employees Provident Fund and Miscellaneous Provisions Act, 1952.	
IV	**Constitution and Labour Laws** labour laws, Equality before law and its application in Labour Laws, Equal pay for equal work; and Article-16 and reservation policies, Articles 19, 21, 23 and 24 and its implications.	4
V	**Intellectual Property in Cyber Space** Computer Software and Copyright Law, Software Licences, Computer Databases and the law, Domain Names and the law, Trademark issues in cyberspace	4
VI	**Cyber Crimes and Cyber Laws** Cyber Crimes, Malware, Computer Source Code, Digital Signature, Information Technology Laws, IT ACT & how to prevent yourself from being a victim of Cyber Crime.	5

Text Books	
1	P.L. Mehta, Managerial Economics Analysis, Problems and cases, S. Chand & Co.Ltd., 2001
2	Dieter G.E., Engineering Design, McGraw-Hill Education 5 th edition, 2012.
3	N. Godbole, S. Belapure, “Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives”, Wiley India Pvt. Ltd.
4	Canter, L. W, Environmental Impact Assessment, McGraw-Hill, 2 nd Edition, 1997.
5	“Environmental Auditing”, Published by CPCB, Govt. of India Publication, New Delhi.

References	
1	Peterson and Lewis: Managerial Economics, 4 th Ed., Prentice Hall , 2004
2	R. Drefuss, J. Pila; The Oxford Handbook of Intellectual Property Law, Oxford University Press, 2018.
3	Adv. P. Mali, Cyber Law & Cyber Crimes Simplified, Cyber Infomedia, 2017.
4	No.29 of 1986, [23/5/1986] - The Environment (Protection) Act, 1986, amended 1991
5	G.S.R.830(E), [24/11/2011] - The Water (Prevention and Control of Pollution) Amendment Rules, 2011.
6	No.14 of 1981, [29/3/1981] - The Air (Prevention and Control of Pollution) Act 1981, amended 1987

Useful Links	
1	

CO-PO Mapping	
	Programme Outcomes (PO)

	1	2	3	4	5	6
CO1				2		
CO2		2			1	
CO3				2		

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High

Each CO of the course must map to at least one PO.

Assessment (for Theory Course)

The assessment is based on 2 in-semester examinations in the form of T1 (Test-1) and T2 (Test-2) of 20 marks each. Also, there shall be 1 End-Sem examination (ESE) of 60 marks. T1 shall be typically on modules 1 and 2, T2 based typically on modules 3, 4 and ESE shall be on all modules with nearly 50% weightage on modules 1 to 4 and 50% weightage on modules 5, 6.

Assessment Plan based on Bloom's Taxonomy Level (Marks) For Theory Course

Bloom's Taxonomy Level		**T1**	**T2**	**ESE**	**Total**
1	Remember				
2	Understand				
3	Apply	5	5	20	30
4	Analyze	5	5	20	30
5	Evaluate	10	10	20	40
6	Create				
Total		**20**	**20**	**60**	**100**

Walchand College of Engineering, Sangli

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AY 2021-22

Course Information	
Programme	M. Tech. (Control System Engineering)
Class, Semester	Second Year M. Tech., Sem I
Course Code	5CS690
Course Name	Dissertation Phase I
Desired Requisites:	Concept knowledge of research methodology, project management, Electrical Engineering

Teaching Scheme (Hrs)		**Examination Scheme (Marks)**			
Lecture	-	**LA1**	**LA2**	**ESE**	**Total**
Tutorial	-	30	30	40	100
Practical	20				
Interaction	-	**Credits: 10**			

Course Objectives	
1	To develop the student to apply the knowledge gained to identify problems for research and provide the solutions by self-study and interaction with stakeholders.
2	Acquire knowledge to tackle real world problems of societal concerns
3	Impart flexibility to the student to have increased control over his/ her learning
4	Teachers would serve as mentor/facilitator of inquiry and reflection rather than as an instructor
5	Enhance a students' learning through increased interaction with peers and colleagues.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, students will be able to,

CO1	**Search** the existing literature and identification of research problem	Analyze
CO2	**Design and develop** the solution for complex engineering problem	Evaluate
CO3	**Create** the new knowledge in the specialized field	Create

Course Content

In dissertation Phase 1, the student has to complete the partial work of the Dissertation in Electrical Engineering which will consist of problem statement, literature review from IEEE Transactions and Journals, design, and scheme of implementation (viz. Block diagram, Mathematical Model, Algorithm, Simulation tool, hardware setup requirements etc.)

The student is expected to complete the dissertation at least up to the design phase. As a part of the progress report of Dissertation Phase I, the candidate shall deliver a presentation on the advancement in Technology pertaining to the selected dissertation topic.

The student shall submit the duly approved and certified progress report of Dissertation Phase I in

standard format for satisfactory completion of the work by the concerned guide and head of the Department. The student will be assessed by a panel of examiners in the department for LA. In ESE there will be one external examiner, internal examiner/guide and a chairman for assessment. The assessment will be broadly based on literature study, work undergone, content delivery, presentation skills, documentation and report.

Text Books	
1	As per the research topic

References	
1	National and International Journals

Useful Links	
1	https://nptel.ac.in/courses/121/106/121106007/
2	https://www.youtube.com/watch?v=mAVswCbz_jM&feature=emb_imp_woyt
3	https://nptel.ac.in/courses/110/104/110104073/
4	https://nptel.ac.in/courses/110/107/110107081/

CO-PO Mapping

	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1	1			1		2
CO2	1		1		2	1
CO3		2				1

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High

Each CO of the course must map to at least one PO.

Assessment

There are three components of lab assessment, LA1, LA2 and Lab ESE.

IMP: Lab ESE is a separate head of passing. LA1, LA2 together is treated as In-Semester Evaluation.

Assessment	**Based on**	**Conducted by**	**Typical Schedule (for 26-week Sem)**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 6 Marks Submission at the end of Week 6	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 7 to Week 12 Marks Submission at the end of Week 12	30
Lab ESE	Lab activities, attendance, journal	Lab Course Faculty	During Week 15 to Week 18 Marks Submission at the end of Week 18	40

Week 1 indicates starting week of a semester. The typical schedule of lab assessments is shown, considering a 26-week semester. The actual schedule shall be as per academic calendar. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course.

Assessment Plan based on Bloom's Taxonomy Level (Marks) (For lab Courses)

Bloom's Taxonomy Level	**LA1**	**LA2**	**Lab ESE**	**Total**
Remember				
Understand				
Apply				

Analyze	10	10	10	**30**
Evaluate	10	10	10	**30**
Create	10	10	20	**40**
Total Marks	**30**	**30**	**40**	**100**

Walchand College of Engineering, Sangli

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AY 2021-22

Course Information	
Programme	M. Tech. (Control System Engineering)
Class, Semester	Second Year M. Tech., Sem I
Course Code	5CS602
Course Name	Industry Orientation Course
Desired Requisites:	

Teaching Scheme (Hrs)		**Examination Scheme (Marks)**			
Lecture	-	**LA1**	**LA2**	**ESE**	**Total**
Tutorial	-	30	30	40	100
Practical	-				
Interaction	1	**Credits: 1**			

Course Objectives	
1	To provide a hands on experience of software in solving complex electrical engineering problems.
2	To enhance the employability of electrical control engineering student.

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, students will be able to,		
CO1	**Use** of the software related to design of electrical system effectively.	Evaluate
CO2	**Develop** the solution for electrical engineering problem using software.	Create
CO3	**Explain** the working of research and development department.	Understand

Course Content

This course is based on computers as a tool to design and analyse the electrical system. In the modern day work environment, Electrical Engineer should be able to simulate and solve complex problems on computers. Electrical Engineer must be highly computer literate. The engineer with strong fundamentals in Control Engineering and computer software proficiency is highly in demand from industry. Employability of the student can be enhanced by providing software training of Analysis and simulation software in electrical engineering.

Text Books	
1	Suitable books based on the software selected.

References	
1	Suitable books based on the contents of software selected

Useful Links	
1	As per the need of the software training

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1		1				
CO2			2			2
CO3				3		
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High Each CO of the course must map to at least one PO.						

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing. LA1, LA2 together is treated as In-Semester Evaluation.				
Assessment	**Based on**	**Conducted by**	**Typical Schedule (for 26-week Sem)**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 6 Marks Submission at the end of Week 6	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 7 to Week 12 Marks Submission at the end of Week 12	30
Lab ESE	Lab activities, attendance, journal	Lab Course Faculty	During Week 15 to Week 18 Marks Submission at the end of Week 18	40
Week 1 indicates starting week of a semester. The typical schedule of lab assessments is shown, considering a 26-week semester. The actual schedule shall be as per academic calendar. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments.				

Assessment Plan based on Bloom's Taxonomy Level (Marks) (For lab Courses)				
Bloom's Taxonomy Level	**LA1**	**LA2**	**Lab ESE**	**Total**
Remember				
Understand	10	10	10	**30**
Apply				
Analyze				
Evaluate	10	10	15	**35**
Create	10	10	15	**35**
Total Marks	**30**	**30**	**40**	**100**

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Course Information

Programme	M. Tech. (Control System Engineering)
Class, Semester	Second Year M. Tech., Sem I
Course Code	5CS611
Course Name	Professional Elective 5: Modern Power Electronics
Desired Requisites:	Power Electronics

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	2 Hrs/week	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-				
Interaction	-	**Credits: 2**			

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 Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO1	**Interpret** configuration and working of various Power Electronic converters.	Apply
CO2	**Analyze** various Power Electronic converters and systems.	Analyze
CO3	**Evaluate** various power electronic systems using power electronic converters.	Evaluate

Module	**Module Contents**	**Hours**
I	**PWM rectifiers** Advantages & disadvantages of three phase thyristor converter, Single phase and three phase VSI PWM converters working, types, Control of PWM rectifiers, analysis and application. Three phase CSI PWM converter, control and applications.	5
II	**Multilevel inverters** Three phase two level Voltage source inverter, various PWM methods, Multilevel Voltage source inverter, Types: Diode clamp multilevel inverter, flying capacitor multilevel inverter, cascaded multilevel inverter, applications of multilevel inverters, comparison of multilevel inverter. Control method: Multiple carrier PWM for MLI	5
III	**Resonant pulse inverters** Series resonant inverter with unidirectional and bi-directional switches,	5

	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 and control technique.	
IV	**Photovoltaic Inverters** 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.	5
V	**Matrix Converters and Z source inverters** 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.	4
VI	**Active power filters** Power Quality Issues due to power Electronics, Introduction to active power filter, types of active power filters overall control of shunt active power filter, control of shunt active filter based on SRF theory. Control of shunt active filter based on instantaneous power theory. harmonic compensation & reactive power compensation.	4

Text Books	
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.
Useful Links	
1	NPTEL lectures on Advanced Power Electronics

CO-PO Mapping

	Programme Outcomes (PO)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1			1			
CO2				1		
CO3				2		1

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High

Each CO of the course must map to at least one PO.

Assessment (for Theory Course)
The assessment is based on 2 in-semester examinations in the form of T1 (Test-1) and T2 (Test-2) of 20 marks each. Also there shall be 1 End-Sem examination (ESE) of 60 marks. T1 shall be typically on modules 1 and 2, T2 based typically on modules 3, 4 and ESE shall be on all modules with nearly 50% weightage on modules 1 to 4 and 50% weightage on modules 5, 6.

Assessment Plan based on Bloom's Taxonomy Level (Marks) For Theory Course					
Bloom's Taxonomy Level		**T1**	**T2**	**ESE**	**Total**
1	Remember				
2	Understand				
3	Apply		10	20	**30**
4	Analyze	10		20	**30**
5	Evaluate	10	10	20	**40**
6	Create				
Total		**20**	**20**	**60**	**100**

Walchand College of Engineering, Sangli

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Course Information

Programme	M.Tech. (Control System Engineering)
Class, Semester	Second Year M. Tech., Sem I
Course Code	5CS612
Course Name	Professional Elective 5: Robust Control
Desired Requisites:	Engineering Mathematics

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	2 Hrs/week	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-				
Interaction	-	**Credits: 2**			

Course Objectives

1	This course provides the basic concepts of robust control.
2	It provides the methodology of design of robust control.
3	It gives the overview of h-infinity design

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO1	**Explain** basic concepts of robust control.	Understanding
CO2	**Apply** robust control design and stability analysis	Applying
CO3	**Analyze** the $H^{\infty}-$Control.	Analyzing

Module	**Module Contents**	**Hours**
I	**Robust Control** Introduction to Basic Concepts, Systems and Signals, Stability of LTI Systems, Controller design, Loop shaping, Closed loop Transfer function loop shaping, Linear Fractional transformations**.**	5
II	**Stabilizing Controllers** Internal stability, stabilizing controllers, Stabilizing Controllers - State-Space Descriptions, stability analysis in frequency domain, system norms	5
III	**Limitations on Performance** Limitations on performance SISO and MIMO systems, sensitivity, time lags, uncertainties, phase lag, performance requirements imposed by disturbances and commands.	5
IV	**Uncertainty and Robustness** Introduction to robustness, Uncertainties and representation, Configuration, Types of Uncertainties of System Components, SISO Robust performance and Stability.	4

V	**Robust Stability and Performance** General control configuration, representing uncertainty, Introduction to Stability and Robust Performance Test, structured and unstructured uncertainty, SSV ,mu-synthesis and DK iteration.	4
VI	**Controller Design** LQG control, H2 and H∞−Control, H∞ loop shaping,, H∞ loop shaping design, introduction to model reduction techniques , balanced realizations, hankel norm approximation, reduction of unstable models.	5

Text Books	
1	Kemin Zhou, "*Essentials of Robust Control*", Prentice Hall Publications, 1997.
2	Kemin Zhou, John Doyle, "*Robust and Optimal Control*", Feher-Prentice Hall Publications, 1995.

References	
1	P. H. Petkov, M.M. Konstantinov, "*Robust Control Systems*", Springer Publications, 2005.
2	Sigurd Skogestad, Ian Postlethwaite, "*Multivariable Feedback Control*", Wiley Publications, 2005.

Useful Links	
1	-

CO-PO Mapping

	Programme Outcomes (PO)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1			1			
CO2				1		
CO3				2		1

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High

Each CO of the course must map to at least one PO.

Assessment (for Theory Course)

The assessment is based on 2 in-semester examinations in the form of T1 (Test-1) and T2 (Test-2) of 20 marks each. Also there shall be 1 End-Sem examination (ESE) of 60 marks. T1 shall be typically on modules 1 and 2, T2 based typically on modules 3, 4 and ESE shall be on all modules with nearly 50% weightage on modules 1 to 4 and 50% weightage on modules 5, 6.

Assessment Plan based on Bloom's Taxonomy Level (Marks) For Theory Course					
Bloom's Taxonomy Level		**T1**	**T2**	**ESE**	**Total**
1	Remember				
2	Understand	10		20	30
3	Apply	10	10	20	40
4	Analyze		10	20	30
5	Evaluate				
6	Create				
Total		**20**	**20**	**60**	**100**

Walchand College of Engineering, Sangli

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Course Information

Programme	M. Tech. (Control System Engineering)
Class, Semester	Second Year M. Tech., Sem I
Course Code	5CS651
Course Name	Activity based elective lab 2: Modern Power Electronics
Desired Requisites:	Power Electronics

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	-	**LA1**	**LA2**	**ESE**	**Total**
Tutorial	-	30	30	40	100
Practical	2 Hrs/week				
Interaction	-	**Credits: 1**			

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 Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO1	**Interpret** configuration and working of various Power Electronic converters.	Apply
CO2	**Analyze** various Power Electronic converters and systems.	Analyze
CO3	**Evaluate** various power electronic systems using power electronic converters.	Evaluate

List of Experiments / Lab Activities

Lab activities/performance shall include mini project, presentations, drawings, case study, report writing, site visit, lab experiment, tutorials, assignments, group discussion, programming, and other suitable activities as per nature and requirement of lab course.

Text Books

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.

Useful Links

1	NPTEL lectures on Advanced Power Electronics

CO-PO Mapping						
	Programme Outcomes (PO)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1			1			
CO2				1		
CO3				2		1
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High Each CO of the course must map to at least one PO.						

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing. LA1, LA2 together is treated as In-Semester Evaluation.				
Assessment	**Based on**	**Conducted by**	**Typical Schedule (for 26-week Sem)**	**Marks**
LA1	Lab activities, attendance	Lab Course Faculty	During Week 1 to Week 6 Marks Submission at the end of Week 6	30
LA2	Lab activities, attendance	Lab Course Faculty	During Week 7 to Week 12 Marks Submission at the end of Week 12	30
Lab ESE	Lab activities, attendance	Lab Course Faculty	During Week 15 to Week 18 Marks Submission at the end of Week 18	40
Week 1 indicates starting week of a semester. The typical schedule of lab assessments is shown, considering a 26-week semester. The actual schedule shall be as per academic calendar. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course.				

Assessment Plan based on Bloom's Taxonomy Level (Marks) (For lab Courses)				
Bloom's Taxonomy Level	**LA1**	**LA2**	**Lab ESE**	**Total**
Remember				
Understand				
Apply	10	10	10	**30**
Analyze	10	10	20	**40**
Evaluate	10	10	10	**30**
Create				
Total Marks	**30**	**30**	**40**	**100**

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Course Information	
Programme	M.Tech. (Control System Engineering)
Class, Semester	Second Year M. Tech., Sem I
Course Code	5CS652
Course Name	Activity based elective lab 2: Robust Control
Desired Requisites:	Engineering Mathematics

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	-	**LA1**	**LA2**	**ESE**	**Total**
Tutorial	-	30	30	40	100
Practical	2 Hrs/week				
Interaction	-	**Credits: 1**			

Course Objectives	
1	This course provides the basic concepts of robust control.
2	It provides the methodology of design of robust control.
3	It gives the overview of h-infinity design

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO1	**Explain** basic concepts of robust control.	Understanding
CO2	**Apply** robust control design and stability analysis	Applying
CO3	**Analyze** the H∞−Control.	Analyzing

List of Experiments / Lab Activities

Lab activities/performance shall include mini project, presentations, drawings, case study, report writing, site visit, lab experiment, tutorials, assignments, group discussion, programming, and other suitable activities as per nature and requirement of lab course.

Text Books

1	Kemin Zhou, "*Essentials of Robust Control*", Prentice Hall Publications, 1997.
2	Kemin Zhou, John Doyle, "*Robust and Optimal Control*", Feher-Prentice Hall Publications, 1995.

References

1	P. H. Petkov, M.M. Konstantinov, "*Robust Control Systems*", Springer Publications, 2005.
2	Sigurd Skogestad, Ian Postlethwaite, "*Multivariable Feedback Control*", Wiley Publications, 2005.

Useful Links							
1	-						
	CO-PO Mapping						
		Programme Outcomes (PO)					
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
	CO1			1			
	CO2				1		
	CO3				2		1
	The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High Each CO of the course must map to at least one PO.						

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing. LA1, LA2 together is treated as In-Semester Evaluation.				
Assessment	**Based on**	**Conducted by**	**Typical Schedule (for 26-week Sem)**	**Marks**
LA1	Lab activities, attendance	Lab Course Faculty	During Week 1 to Week 6 Marks Submission at the end of Week 6	30
LA2	Lab activities, attendance	Lab Course Faculty	During Week 7 to Week 12 Marks Submission at the end of Week 12	30
Lab ESE	Lab activities, attendance	Lab Course Faculty	During Week 15 to Week 18 Marks Submission at the end of Week 18	40
Week 1 indicates starting week of a semester. The typical schedule of lab assessments is shown, considering a 26-week semester. The actual schedule shall be as per academic calendar. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course.				

Assessment Plan based on Bloom's Taxonomy Level (Marks) (For lab Courses)				
Bloom's Taxonomy Level	**LA1**	**LA2**	**Lab ESE**	**Total**
Remember				
Understand	10	10	10	**30**
Apply	10	10	20	**40**
Analyze	10	10	10	**30**
Evaluate				
Create				
Total Marks	**30**	**30**	**40**	**100**

Walchand College of Engineering, Sangli

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Course Information

Programme	M. Tech. (Control System Engineering)
Class, Semester	Second Year M. Tech., Sem II
Course Code	5CS691
Course Name	Dissertation Phase 2
Desired Requisites:	Dissertation Phase 1

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	-	**LA1**	**LA2**	**ESE**	**Total**
Tutorial	-	30	30	40	100
Practical	24 Hrs/week				
Interaction	-	**Credits: 12**			

Course Objectives

1	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 I and II respectively.

Course Outcomes (CO) with Bloom's Taxonomy Level

CO 1	**Defend** the objectives of the dissertation by grasping and analysing through an extensive literature review in the area of study.	Understand Analyse Evaluate
CO 2	**Formulate** the methodology and **Execute** the study through conduct of Analytical/Experimental work to achieve the objectives.	Apply Create
CO 3	**Analyse, interpret** and **critique** the findings of the study.	Apply Analyse Evaluate
CO 4	**Defend** the outcomes of the dissertation through self-learning and justify the project work as per appropriate standards of documentation and presentation.	Evaluate

Lab Activities / 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.	
Text Books	
1	----------
References	
1	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.
Useful Links	
1	----------

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1	3	2			2	
CO2	2		3	3		
CO3				2	1	2
CO4		3			2	2
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:HighEach CO of the course must map to at least one PO.						

Assessment

Assessment	Marks
LA1	30
LA2	30
Lab ESE	40

LA1,LA2 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.

LA1,LA2 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.

Assessment Plan based on Bloom's Taxonomy Level				
Bloom's Taxonomy Level	**LA1**	**LA2**	**ESE**	**Total**
Remember				
Understand	10			**10**
Apply	10	10		**20**
Analyze	10	10	20	**40**
Evaluate		10	10	**20**
Create			10	**10**
Total	**30**	**30**	**40**	**100**

Walchand College of Engineering, Sangli

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Course Information	
Programme	M. Tech. (Control System Engineering)
Class, Semester	Second Year M. Tech., Sem IV
Course Code	5CS671
Course Name	Techno-Socio Activity
Desired Requisites:	

Teaching Scheme (Hrs)		**Examination Scheme (Marks)**			
Lecture	-	**LA1**	**LA2**	**ESE**	**Total**
Tutorial	-	30	30	40	100
Practical	-				
Interaction	1	**Credits: 1**			

Course Objectives	
1	To record student performance in co-curricular and extra-curricular activities over two years will be considered.
2	To encourage the students to participate in activities that help develop leadership skills, team integrity, coordination skills, Time management, Communications skills, Interviewing skills etc.
3	To highlight importance of social responsibility.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, students will be able to,

CO1	**Notice** an improvement in his/her understanding and presentation skills.	Apply
CO2	**Understand** and value the importance of working in a diversified team.	Analyze
CO3	**Demonstrate** the soft skills like presentation skills, technical report writing etc.	Evaluate

Course Contents

The guide will be mentoring a given student batch for the duration of two years. The students shall submit proof of their achievements in various extra and co-curricular activities related to technical, cultural and social causes from first year to second year. The faculty will evaluate the students' performance at the end of 4thsemester, based on the rubrics provided by the department from time to time.

Text Books	
1	Not applicable

References	
1	Not applicable

Useful Links	
1	Not applicable

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2				3	
CO2		1			2	
CO3			2		3	
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High Each CO of the course must map to at least one PO.						

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing. LA1, LA2 together is treated as In-Semester Evaluation.				
Assessment	**Based on**	**Conducted by**	**Typical Schedule (for 26-week Sem)**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 6 Marks Submission at the end of Week 6	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 7 to Week 12 Marks Submission at the end of Week 12	30
Lab ESE	Lab activities, attendance, journal	Lab Course Faculty	During Week 15 to Week 18 Marks Submission at the end of Week 18	40
Week 1 indicates starting week of a semester. The typical schedule of lab assessments is shown, considering a 26-week semester. The actual schedule shall be as per academic calendar. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments.				

Assessment Plan based on Bloom's Taxonomy Level (Marks) (For lab Courses)				
Bloom's Taxonomy Level	**LA1**	**LA2**	**Lab ESE**	**Total**
Remember				
Understand				

Apply	10	10	10	**30**
Analyze	10	10	15	**35**
Evaluate	10	10	15	**35**
Create				
Total Marks	**30**	**30**	**40**	**100**

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Course Information

Programme	M.Tech. (Control System Engineering)
Class, Semester	Second Year M. Tech., Sem II
Course Code	5CS621
Course Name	Professional Elective 6: Robotics and AI
Desired Requisites:	Electrical Machines, Instrumentation, Control System Engineering

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-				
Interaction	-	**Credits: 3**			

Course Objectives

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

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO1	**Analyze** various models of robots and their dynamics.	Analysing
CO2	**Analyze** problems associated with open loop and closed loop robot control system	Analysing
CO3	**Design** various conventional and advanced controllers for robotics.	Creating

Module	**Module Contents**	**Hours**
I	**Introduction** Introduction -- brief history, types, classification and usage Position and orientation of a rigid body, Homogeneous transformations, Representation of joints, link representation using D-H parameters, Examples of D-H parameters and link transforms.	6
II	**Elements of robots -- joints, links, actuators, and sensors** 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
III	**Kinematics of robots** Introduction, Direct and inverse kinematics problems, Examples of	6

	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.	
IV	**Velocity and statics of robot manipulators** 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
V	**Motion planning and control** 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
VI	**AI in Robotics** 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

Text Books	
1	Ashitava Ghosal,' *Robotics: Fundamental Concepts and Analysis'*, 2nd Edition, Oxford University Press, 2008.
2	Mittal R. and Nagrath I., '*Robotics and Control'*, McGraw-Hill publications, 2017.
References	
1	Craig,,' *Introduction to Robotics: Mechanics and Control'*, 3rd Edition, Oxford University Press, 2008
Useful Links	
1	-

CO-PO Mapping						
Programme Outcomes (PO)						
	1	2	3	4	5	6
CO1				2		
CO2				2		
CO3			2			1
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on 2 in-semester examinations in the form of T1 (Test-1) and T2 (Test-2) of 20 marks each. Also there shall be1 End-Sem examination (ESE) of 60 marks. T1 shall be typically on modules 1 and 2, T2 based typically on modules 3,4 and ESE shall be on all modules with nearly 50% weightage on modules 1 to 4 and 50% weightage on modules 5, 6.

Assessment Plan based on Bloom's Taxonomy Level				
Bloom's Taxonomy Level	**T1**	**T2**	**ESE**	**Total**
Remember				
Understand				
Apply				
Analyze	20	10	30	**60**
Evaluate				
Create		10	30	**40**
Total	**20**	**20**	**60**	**100**

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Course Information

Programme	M.Tech. (Control System Engineering)
Class, Semester	Second Year M. Tech., Sem II
Course Code	5CS622
Course Name	Professional Elective 6 : Real Time Control Applications
Desired Requisites:	Microcontroller and Applications, Digital Signal Processing

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3Hrs/week	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-				
Interaction	-	**Credits: 3**			

Course Objectives

1	The course intends to introduce Embedded Control for Control Applications
2	The course aims at developing programs using target Microcontrollers using Matlab and Simulink
3	It intends to analyze the performance of Electrical Systems using advanced techniques like Hardware in loop simulation, Processor-in-loop simulation, etc.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO1	**Implement** programs to solve real time control problems in Electrical Engineering.	Applying
CO2	**Examine** the performance of real time control system for various applications.	Evaluate
CO3	**Perform** real time simulations and/or hardware-in-loop simulations using target hardware like Arduino, dSpace, TI boards etc.	Creating

Module	**Module Contents**	**Hours**
I	**Introduction** Overview of System Simulation Techniques, Target Hardware Selection, Data types, Matrix Computations in Matlab, Flow structures: Conditional structures, Loop Structures, Accelerating Matlab functions, Execution time and profiles	6
II	**MATLAB applications in Scientific Computations** Solutions to Linear Algebra Problems: Matrix Analysis and Computation, Matrix Equations, Non-linear Matrix functions, Solutions	6

	of Calculus Problems, Solutions of Ordinary Differential Equations, Non-linear equation solution and optimization	
III	**Modeling and Simulation of Engineering systems** Physical system modeling with Simscape, Description of SimPowerSystems, Modeling and simulation of Electronics circuits, simulation of motors and electric drive systems	6
IV	**Microcontrollers for Real-time Control Applications** Selection of Microcontroller for Control Applications, Sampling frequency selection, Features, Architecture and Specifications of Arduino Microcontrollers, Piccolo and Delfino Microcontrollers	6
V	**Microcontroller Configuration for Real-time Applications** Arduino, Delfino and Piccolo configuration in Matlab/Simulink Environment, Timer applications, Analog to Digital Conversion examples, PWM configuration and examples, Applications in Power Electronics and Control Systems	6
VI	**Introduction to Hardware-in-loop Simulations** External mode simulations, Simulink and real-time workshop, Hardware-in-loop simulation techniques, code generation, Introduction to dSpace and its blocks, Hardware-in-loop simulations using Arduino, Processor-in-loop simulations, Applications of Arduino Control, dSpace Control, Case studies	6

Text Books	
1	DingyuXue, YangQuan Chen, "*System Simulation Techniques with Matlab and Simulink"*, Wiley Publications, Edition I, 2014
2	TI User Manuals TMS320C2x, TMS 28335
References	
1	Website www.ti.com and www.DSPguide.com.
2	Harold Klee, Randal Allen,"*Simulation of Dynamic Systems with MATLAB® and Simulink"*, CRC Press, Third Edition, 2011.
3	KatalinPopovici, Pieter J. Mosterman , *"Real-time Simulation Technologies: Principles, Methodologies, and Applications"* ,CRC Press, 2012.

CO-PO Mapping

Programme Outcomes (PO)						
	1	2	3	4	5	6
CO1			2			
CO2				2		
CO3						2

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High

Each CO of the course must map to at least one PO.

Assessment
The assessment is based on 2 in-semester examinations in the form of T1 (Test-1) and T2 (Test-2) of 20 marks each. Also there shall be1 End-Sem examination (ESE) of 60 marks. T1 shall be typically on modules 1 and 2, T2 based typically on modules 3,4 and ESE shall be on all modules with nearly 50% weightage on modules 1 to 4 and 50% weightage on modules 5, 6.

Assessment Plan based on Bloom's Taxonomy Level				
Bloom's Taxonomy Level	**T1**	**T2**	**ESE**	**Total**
Remember				
Understand				
Apply	10	10	30	**50**
Analyze				
Evaluate	10	10	20	**40**
Create			10	**10**
Total	**20**	**20**	**60**	**100**