ACADEMIC CURRICULA

Professional Core Courses

MECHATRONICS ENGINEERING

Regulations - 2018

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18MHC101J	Course Name	MECHANICS OF SOLIDS AND FLUIDS	Course Category	C	*Professional Core*	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Mechatronics Engineering*	Data Book / Codes/Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	*Understand the behavior of materials under load*			
CLR-2 :	*Identify types of beam and understand their deflection under different types of load*			
CLR-3 :	*Understand the behavior of materials under torque*			
CLR-4 :	*Analyze the buckling load for columns with different support conditions.*			
CLR-5 :	*Analyze the physical behavior of fluids using the concepts of continuity equation and Bernoulli's theorem.*			
CLR-6 :	*Explain the basic idea of dimensional analysis*			

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Estimate the different types of stress induced in material*	*3*	*90*	*85*	*H*	*H*	*M*	-	*L*	-	-	-	*H*	-	-	-	*H*	-	*H*
CLO-2 :	*Analyze the shear force and bending moment in beam*	*3*	*85*	*80*	*H*	*H*	*M*	-	*L*	-	-	-	*H*	-	-	-	*H*	-	*H*
CLO-3 :	*Calculate torque induced in shaft*	*3*	*90*	*85*	*H*	*H*	*M*	-	*L*	-	-	-	*H*	-	-	-	*H*	-	*H*
CLO-4 :	*Analyze the buclking of column.*	*3*	*85*	*80*	*H*	*H*	*M*	-	*L*	-	-	-	*H*	-	-	-	*H*	-	*H*
CLO-5 :	*Dertermine the coefficient of discharge of different devices*	*3*	*85*	*80*	*H*	*H*	*M*	-	*L*	-	-	-	*H*	-	-	-	*H*	-	*H*
CLO-6 :	*Estimate losses in pipes*	*3*	*85*	*80*	*H*	*H*	*M*	-	*L*	-	-	-	*H*	-	-	-	*H*	-	*H*

		Stress, Strain and Deformation of Solids	Transverse Loading on Beams, Shear Force and Bending Moment	Torsion and Columns	Fluid Flow Concepts and Dynamics of Fluids	Dimensional Analysis and Flow through Pipes
Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Concept of stress-strain and its types, Hooke's law, modulus of elasticity*	*Types of beams and loadings, shear force and bending moments*	*Theory of torsion*	*Introduction to Fluids Mechanics*	*Introduction of Dimensions and units*
	SLO-2	*Factor of safety, Poisson's ratio, elastic constants and their relationship*	*Sign convention for shear force and bending moments*	*Derive torsional equation*	*Properties of fluid*	*Concepts of dimensional homogeneity, Rayleigh method*
S-2	SLO-1	*Analysis of bars of uniform cross sections subjected to different loads*	*Analyze shear force, bending moment for cantilever beam with point load at free end*	*Analyze torque transmitted by a solid shaft*	*Application of fluid*	*Problems in Rayleigh method*
	SLO-2	*Analysis of bars varying cross sections subjected to different loads*	*Analyze shear force, bending moment for cantilever beam with different loads at different points*	*Problems in Analysis of torque transmitted by a solid shaft*	*Basics numerical problem in fluid properties*	*Application of Rayleigh method*
S-3	SLO-1	*Problems in Analysis of bars of uniform cross sections subjected to different loads.*	*Problems in Analysis of shear force and bending moment for cantilever beam with Uniformly Distributed Load*	*Analyze torque transmitted by a hollow shaft*	*Derivation of Continuity Equation*	*Introduction of Buckingham's Π theorem*
	SLO-2	*Problems in Analysis of bars of varying cross sections subjected to different loads*		*Problems in Analysis of torque transmitted by a hollow shaft*	*Problems in velocity and discharge of fluids in pipe using continuity equation*	*Properties of Buckingham's Π theorem*

S 4-5	SLO-1	*Lab 1: Tensile test on mild steel*	*Lab 4: Charpy and Izod impact test on steel specimen*	*Lab 7: Torsional test on mild steel*	*Lab 10: Determine coefficient of discharge of Orificemeter*	*Lab 13: Verify Bernoulli's theorem*
	SLO-2					
S-6	SLO-1	*Principle of superposition*	*Analyze shear force and bending moment for simply supported beam with point loads*	*Analysis of strength of varying cross sections of shafts*	*Equations of motion, derivation of Euler's equation and Bernoulli's equation*	*Numerical problems in Buckingham's Π theorem*
	SLO-2	*Problems in Principle of Superposition*	*Analysis of shear force, bending moment for simply supported beam with UDL*	*Analysis of strength of varying cross sections of shafts*	*Derive Euler's equation and Bernoulli's equation*	*Advantage and disadvantage of Rayleigh method and Buckingham's Π theorem*
S-7	SLO-1	*Analyze uniform and varying cross section of composite bar*	*Problems in cantilever beams*	*Problems in shafts with varying cross section*	*Problems in Euler's equation and Bernoulli's equation*	*Introduction of Losses in pipes*
	SLO-2	*Problems in composite bar with uniform and varying cross section*	*Problems in simply supported beams*	*Problems in shafts with varying cross section*	*Assumptions and Disadvantages of Bernoulli's equation*	*Types of losses, analysis of Minor losses in pipes*
S-8	SLO-1	*Analyze stress in composite bars due to temperature difference.*	*Analyze shear force, bending moment for overhanging beam with point loads and UDL*	*Types of columns, applications*	*Application of Bernoulli's equation*	*Problems in Minor losses*
	SLO-2	*Problems in stress in composite bars due to temperature difference*	*Analyze shear force, bending moment for overhanging beam with point loads and UDL*	*Expression for buckling load of columns with different support conditions*	*Introduction to Venturimeter*	*Problems in Minor losses*
S 9-10	SLO-1	*Lab 2: Deflection test on different beams*	*Lab 5: Double shear and (or) Compression test*	*Lab 8: Fatigue test*	*Lab 11: Determine coefficient of discharge of Venturimeter*	*Lab 14: Determine Minor losses: Expansion and contraction losses in pipes*
	SLO-2					
S-11	SLO-1	*Principal plane and Principal stresses*	*Analyze maximum bending moment and point of contraflexure in overhanging beam*	*Determine buckling load for columns with different support conditions using Euler's formula*	*Derivation and assumption of Venturimeter*	*Introduction to Major losses in pipes*
	SLO-2	*Analysis of direct stresses in one plane and two mutually perpendicular planes*	*Analysis of maximum bending moment and point of contraflexure in overhanging beam*	*Determine buckling load for columns with different support conditions using Euler's formula*	*Problems in Venturimeter*	*Problems in Darcy Weisbach and Chezy formula*
S-12	SLO-1	*Analyze direct stresses in one plane and two mutually perpendicular planes using Mohr's circle*	*Theory and assumption of simple bending in beam*	*Problem in buckling*	*Introduction to Orifice meter*	*Analyze discharge, velocity of fluids flows through pipes in series*
	SLO-2		*Derivation of simple bending in a beam*	*Determine buckling load for columns with different support conditions using Euler's formula*	*Derivation and assumption of Orifice meter*	*Analyze discharge, velocity of fluids flows through pipes in parallel*
S-13	SLO-1	*Problems in Analysis of direct stresses in one plane and two mutually perpendicular planes*	*Numerical Problems in theory of simple bending in beam*	*Determine buckling load for columns with different support conditions using Euler's formula*	*Numerical Problems in Orificemeter*	*Construction and working principle of centrifugal pump*
	SLO-2		*Analysis of bending stress in symmetrical and unsymmetrical beam section*	*Problems in columns using Euler's formula*	*Application of Orifice meter*	*Construction and working principle of reciprocating pump*
S 14-15	SLO-1	*Lab 3: Deflection test on different beams*	*Lab 6: Charpy and Izod impact test on steel specimen*	Lab 9: *Fatigue test*	*Lab 12: Determine Major losses in pipe flow*	*Lab 15: Determine Minor losses: Expansion and contraction losses in pipes*
	SLO-2					

Learning Resources	1. *Bansal. R. K, Strength of Materials, 6th ed., Lakshmi publications Pvt. Ltd., 2018* 2. *Ramamurtham S and Narayanan R, Strength of Materials, 18th ed., DhanpatRai Pvt. Ltd., 2018* 3. *Bansal. R. K, Fluid Mechanics and Hydraulic Machines, 10th ed., Laxmi publications (P) Ltd., 2018*	4. *Kumar. K. L, Engineering Fluid Mechanics, 8th ed., S. Chand and co limited, 2012* 5. *Timoshenko. S. P., Gere .M. J, Mechanics of Materials, 5th ed., Stanley Thornes (PUB) Ltd, 1999.* 6. *Strength of Material Laboratory Manual, SRMIST* 7. *Fluid Mechanics Laboratory Manual, SRMIST*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
r. Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. K.Maheshwaran, Senior Engineer, TAFE, Chennai, maheshwaran@tafe.com	*1. Dr. P. Karthikeyan, MIT campus, Anna university, pkarthikeyan@annauniv.edu*	*1. Ms. D. Gayathiri, SRMIST*
2.R.Dhinesh Babu, Senior Engineer, Technofit SDN BHD.,dinesh@technofit.com	*2. Dr.B.Mohan, Professor, Anna University, mohan@mitindia.edu*	*2. Mr. G. Balakumaran, SRMIST*

Course Code	18MHC102T	Course Name	ELECTRICAL MACHINES AND ACTUATORS	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18EES101J	Co-requisite Courses	18MHC104L	Progressive Courses	Nil
Course Offering Department	Mechatronics Engineering	Data Book / Codes/Standards		Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Understand the construction and principle of operation of DC machines			
CLR-2 :	Understand the construction and principle of operation of AC machines			
CLR-3 :	Understand the construction and principle of operation of Special machines			
CLR-4 :	Identify different Control circuits for DC and AC motors			
CLR-5 :	Analyse the DC and AC machines for suitable applications			
CLR-6 :	Apply the Control circuits for different applications			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	Operate different types of DC machines	3	75	70	H	H	-	-	-	L	-	-	-	-	-	M	-	-	-
CLO-2 :	Operate different types of AC machines	3	75	70	H	H	-	-	-	L	-	-	-	-	-	M	-	-	-
CLO-3 :	Operate different types of Special machines	3	75	70	H	M	-	-	-	L	-	-	-	-	-	M	-	-	-
CLO-4 :	Analyze the control circuits for suitable actuation	3	75	70	H	-	M	M	M	L	-	-	-	-	-	M	-	-	-
CLO-5 :	Apply the different machines for suitable Applicatios	3	75	70	H	-	M	M	M	L	-	-	H	-	-	M	-	-	-
CLO-6 :	Operate, analyze and apply different machines and control circuits for suitable applications	3	75	70	H	-	M	M	M	L	-	-	H	-	-	M	-	-	-

		DC Machines	Trandformers and Induction Motors	Synchronous and Special Machines	Thyrister for Controller for Actuators	Applications of Actuators
Duration (hour)		9	9	9	9	9
S-1	SLO-1	DC machines: Introduction	Transformer: Construction	Synchronous motor	Introduction to Relays	Applications of actuators
	SLO-2	Construction	Principle, Types of Transformers	Construction	Fuses and Circuit Breakers	Different types of drives
S-2	SLO-1	Principle of operation	Emf equation	Synchronous motor	Introduction to Thyristor	Electric vehicles
	SLO-2	Types of DC machines based on construction	Voltage regulation	Principle of operation	Thyristor Rectifier	DC drive with chopper control for electric vehicle
S-3	SLO-1	Shunt Motor,	Simple problems in Transformers	Methods of starting Synchronous motor	Thyristor Choppers	Introduction to traction
	SLO-2	Series Motor, Compound motor	Introduction to 3-phase system	Difference between Induction and Synchronous motors	Thyristor Choppers	chopper controlled traction drive
S-4	SLO-1	Back Emf, Voltage equations	Three phase induction motor construction	Applications of Synchronous motors	Thyristor Inverters	Robotic gripper
	SLO-2	Torque equation, Simple Problems	principle of operation	Introduction to special machines	Applications of converters	Applications of robotic grippers
S-5	SLO-1	Characteristics of D.C Shunt motor, Series motor	Production of RMF	PMDC motors: Construction	Thyristor controller starters	Introduction to mems
	SLO-2	Speed Control Methods	Production of RMF	principle of operation	Electronic speed control methods for DC motors	Applications of mems actuators
S-6	SLO-1	Necessity of a starter	Torque-slip characteristics	Stepper motors: construction,	Thyristor speed control of DC Shunt Motor	Introduction to solenoids
	SLO-2	Types of Starters	Torque equation	principle of operation of VR, PM Stepper Motors	Thyristor speed control of DC Series Motor	Solenoid operated fuel injection systems

S-7	SLO-1	*3 point Starters*	*Linear Induction Motors: Construction*	*Hybrid type Stepper Motors: Construction*	*Speed control of single phase Induction motor using Inverter*	*Stepper motor throttle actuators*
	SLO-2	*3 point Starters*	*Principle of operation*	*Principle of operation*	*Speed control of single phase Induction motor using Inverter*	*Stepper motor throttle actuators*
S-8	SLO-1	*4 point Starters*	*Difference between Three phase and Single Phase induction Motors*	*BLDC motors: Construction*	*Electronic Speed control of Synchronous Motor*	*Actuators for capsule filling machines*
	SLO-2	*4 point Starters*	*Difference between Three phase and Single Phase induction Motors*	*Principle of operation*	*Driver circuit for Stepper motors*	*Actuators for capsule filling machines*
S-9	SLO-1	*Braking methods- Dynamic and plugging*	*Introduction to Single Phase induction Motors*	*Servo Motors: Types, Construction*	*Unipolar drive for Variable reluctance*	*Actuators for Labelling Machines*
	SLO-2	*Regenerative braking*	*Principle and operation of single phase induction motor*	*Principle of operation*	*Bipolar drive for Permanent Magnet and Hybrid motors*	*Actuators for Labelling Machines*

Learning Resources	*1. B. L Theraja, A. K. Theraja, A text book of electrical technology,Volume II, S.Chand Publications, 2008* *2. S. K. Bhattacharya,S.Chatterjee,industrial Electronics and control, TTTI, Chandigarh*	*3. Gopal K.Dubey, Fundamentals of Electrical drives,Narosa publications 2014*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. N. Gunavardhini, TANGEDCO, Salem, gunatneb1990@gmail.com	*1. Dr. S. S. Dash, Government College of Engineering Kednhhar, Orisha, munu_dash_2k@yahoo.com*	*1. Dr. M. Santhosh Rani, SRMIST*
2. Dr. S. Janardhanam, CAPGEMINI.	*2. Dr. K. Sujatha, Dr. MGR Educational and Research Institute, drksujatha23@gmail.com*	*2. Dr. T. Muthuramalingam, SRMIST*

Course Code	18MHC103T	Course Name	SOLID STATE DEVICES AND CIRCUITS	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18EES101J	Co-requisite Courses	18MHC104L	Progressive Courses	18MHC108L
Course Offering Department	Mechatronics Engineering	Data Book / Codes/Standards		Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Utilize the characteristics of semiconductor devices			
CLR-2 :	Identify the different amplifier using 'h parameter and equivalent circuit'			
CLR-3 :	Build the various concepts of feedback and oscillators and multi vibrators			
CLR-4 :	Utilize the various rectifier and regulator circuits			
CLR-5 :	Identify the different power supply circuits			
CLR-6 :	Gain knowledge on operational amplifiers and its basic applications			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	Describe band theory of solids with special reference to semi-conductors.	2	75	70	H	M	M	H	M	L	M	L	M	M	-	H	H	H	H
CLO-2 :	Design Amplifier using 'h' Parameters and Equivalent Circuits	3	75	70	H	M	M	H	M	L	M	-	M	M	L	H	H	H	H
CLO-3 :	Illustrate the various concepts of feedback and oscillators and multi vibrators	3	75	70	H	M	M	M	L	L	M	L	M	M	L	H	-	-	-
CLO-4 :	Design various Rectifier and Regulator circuits	3	75	70	H	M	M	-	L	L	M	L	-	M	L	H	H	H	H
CLO-5 :	Evaluate the performance of Power Supply Circuits.	3	75	70	H	M	M	H	L	-	M	L	M	M	L	H	-	-	-
CLO-6 :	Gain knowledge on operational amplifiers and its basic applications	3	75	70	H	M	-	H	M	L	M	L	M	M	L	H	H	H	H

		Special Semiconductor Devices	Amplifier	Feedback Circuits	Switching Circuits and Power Supplies	Operational Amplifiers
Duration (hour)		9	9	9	9	9
S-1	SLO-1	Semiconductor devices: Introduction	Introduction to amplifiers. Transistor as an amplifier, FET as an amplifier	Basic concepts of feedback	Basic about Switching action of transistor	Introduction to Operational amplifier
	SLO-2	Classification of semiconductor devices	Types of Biasing	Types-Positive and negative feedback	Concept of Switching action of transistor	Ideal characteristics of op-amp
S-2	SLO-1	Characteristics of Zener diode	Self- biasing of transistor	Principle of feedback in amplifiers	Introduction of astable multivibrator	Internal block diagram of op-amp
	SLO-2	Application of Zener diode	Fixed biasing, Voltage divider biasing	Principle of feedback in oscillators	Working principle of astable multivibrator	Slew rate of op-amp
S-3	SLO-1	Working principle, characteristics Schottky, diode PIN and Shockley diode	Small signal model of BJT	Voltage series network	Introduction of monostable multivibrator	Introduction about DC characteristics of op- amp
	SLO-2	Applications of Schottky, diode PIN and Shockley diode	Two port network of BJT	Voltage shunt network	Working of monostable multivibrator	Concept of DC characteristics op- amp
S-4	SLO-1	Working principle, characteristics Tunnel diode	Hybrid parameter for BJT	Current series network	Introduction of bistable multivibrator	Introduction about AC characteristics of op-amp
	SLO-2	Applications of Tunnel diode and varactor diode	h- parameter model for CE, CB and CC configuration	Current shunt network	Working of bistable multivibrator	Concept of AC characteristics op- amp
S-5	SLO-1	Working principle, characteristics Tunnel diode and varactor diode	h- parameter model for CE configuration and analysis for CE configuration	LC oscillator: Hartley oscillator - working principle	Circuit diagram of Schmitt trigger	Introduction of differential amplifier
	SLO-2	Applications of Tunnel diode and varactor diode	Analysis for CE configuration	Hartley oscillator -derivation for the frequency of oscillation	Working of Schmitt trigger	Types of differential amplifier

S-6	SLO-1	*Working principle, characteristics of thyristor: UJT*	*Power amplifiers: Class A working principle*	*Colpitt's oscillator - working principle*	*Introduction to Rectifiers and its types*	*Inverting buffer amplifier*
	SLO-2	*Applications of Thyristor: UJT*	*Class A derivation for the efficiency*	*Colpitt's oscillator - derivation for the frequency of oscillation*	*Regulators and its types*	*Non-inverting buffer amplifier*
S-7	SLO-1	*Working principle, characteristics of thyristor: SCR*	*Class B working principle*	*Clap oscillator - working principle*	*Circuit diagram and working of Series regulator*	*Basic applications: Inverting Summing amplifier*
	SLO-2	*Applications of thyristor: SCR*	*Class B derivation for the efficiency*	*Clap oscillator - derivation for the frequency of oscillation*	*Circuit diagram and working of Shunt regulator*	*Non-Inverting Summing amplifier*
S-8	SLO-1	*Working principle, characteristics of DIAC*	*Class AB, Class C working principle*	*RC oscillator: RC Phase shift oscillator - working*	*Block diagram of SMPS*	*Subtractor*
	SLO-2	*Applications of DIAC*	*Class AB, Class C derivation for the efficiency*	*RC Phase shift oscillator - derivation for the frequency of oscillation*	*Working principle of SMPS*	*V-I and I-V converter*
S-9	SLO-1	*Working principle, characteristics of TRIAC*	*Tuned amplifiers*	*Wien bridge oscillator - working*	*Block diagram of UPS*	*Introduction and basic concept of Comparator*
	SLO-2	*Applications of TRIAC*	*Types of Tuned amplifiers*	*Wien bridge oscillator - derivation for the frequency of oscillation*	*Working principle of UPS*	*Application of Comparator*

Learning Resources	*1. David A Bell, Electronic devices and circuits, Oxford Publication., 2008* *2. Robert Boylestad and Louis Nashelsky, Electronic devices and circuit theory, 7th ed., Prentice Hall., 2005* *3. Roy Choudhury, Shail B. Jain, Linear integrated circuits, New Age International publishers, 2010*	*4. J. B. Gupta, Electronic devices and Circuits, Sanjay Kumar Kattaria Publication, 2010* *5. Milman., Halkias. C, Electronic devices and circuits, Tata McGraw Hill publications, 2001*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.S.AnandaKumar, Deputy Chief Engineer, Control and Instrumentation, TPS-2, NLC India Limited, sith.anandkumar@gmail.com	*1. Dr. B. Chittibabu, IIITDM, Kanchipuram, bcbabu@iiitdm.ac.in*	*1. Mrs. V. Krithika, SRMIST*
2.Mrs.T.Priya, Kavin Engineering and Services Private Limited, priya@kavinengg.com	*2. Dr. P. Karthikeyan, MIT campus, Anna university, pkarthikeyan@annauniv.edu*	*2. Mr. K. Sridharan, SRMIST*

Course Code	18MHC104L	Course Name	ELECTRICAL AND ELECTRONICS LABORATORY	Course Category	C	*Professional Core*	L	T	P	C
							0	0	4	2

Pre-requisite Courses	*18EES101J*	Co-requisite Courses	*18MHC102T*	Progressive Courses	*Nil*
Course Offering Department	*Mechatronics Engineering*	Data Book / Codes/Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning		
		1	2	3
CLR-1 :	*Design the circuits using discrete components.*			
CLR-2 :	*Understand the basic concepts of integrated circuits and design circuits*			
CLR-3 :	*Understand the basic concepts and operation of DC machines*			
CLR-4 :	*Understand the basic concepts and operation of AC machines*			
CLR-5 :	*Improve their ability in selecting components for particular application*			
CLR-6 :	*Utilize characteristics of semiconductor devices, amplifiers, multivibrator and operational amplifiers and electrical drives*			

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Program Learning Outcomes (PLO)														
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
					Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Implement the functionality of the circuits using discrete components*	*2*	*85*	*80*	*H*	-	-	-	*H*	-	*H*	-	*H*	*H*	-	-	-	-	-
CLO-2 :	*Develop knowledge on basic concepts of integrated circuits and design circuits*	*3*	*85*	*80*	*H*	-	-	*H*	*H*	-	*H*	-	*H*	*H*	-	-	-	-	-
CLO-3 :	*Apply the knowledge on basic concepts in operating DC and AC machines*	*3*	*85*	*80*	*H*	-	-	-	*H*	-	*H*	-	*H*	*H*	-	-	-	-	-
CLO-4 :	*Analyse the Performance Characteristics of DC and AC and Special machines*	*2*	*85*	*85*	*H*	-	-	*H*	*H*	-	-	-	*H*	*H*	-	-	-	-	-
CLO-5 :	*Apply the knowledge in selecting components for particular application*	*2*	*85*	*85*	*H*	-	-	-	-	-	*H*	-	*H*	*H*	-	-	-	-	-
CLO-6 :	*Apply characteristics of semiconductor devices, amplifiers, multivibrator and operational amplifiers and electrical drives*	*3*	*85*	*80*	*H*	-	-	-	-	-	-	-	*H*	*H*	-	-	-	-	-

Duration (hour)		12	12	12	12	12
S 1-4	SLO-1	*Characteristics of PN and Zener diode*	*Rectifiers without filter: Half wave, full wave and bridge*	*Load Test on DC Shunt Motor*	*Load Test on Single Phase Transformer*	*Speed Control of Stepper Motor*
	SLO-2					
S 5-8	SLO-1	*Characteristics of transistor: BJT, UJT*	*Rectifiers with filter: Half wave, full wave and bridge*	*Load Test on DC Series Motor*	*Load Test on Single Phase Induction Motor*	*Characteristics of servo Motor*
	SLO-2					
S 9-12	SLO-1	*Design of oscillator and multivibrator circuits*	*Op Amp: Non-inverting, inverting and buffer amplifier*	*Speed Control of DC Shunt Motor*	*Load Test on Three Phase Induction Motor*	*Interpretation of technical data sheet*
	SLO-2					

Learning Resources	*1. Electronics laboratory manual*	*2. Electrical laboratory manual*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*
	Understand										
Level 2	Apply	-	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*
	Analyze										
Level 3	Evaluate	-	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. N. Gunavardhini, TANGEDCO, Salem, gunatneb1990@gmail.com	*1. Dr,S. S Dash, Government College of Engineering Kednhhar, Orisha, munu_dash_2k@yahoo.com*	*1. Dr. M. Santhosh Rani, SRMIST*
2. Dr. S. Janardhanam, CAPGEMINI	*2. Dr. K. Sujatha, Dr. MGR Educational and Research Institute, drksujatha23@gmail.com*	*2. Dr. T. Muthuramalingam, SRMIST*

Course Code	18MHC105J	Course Name	FLUID POWER SYSTEM AND AUTOMATION	Course Category	C	*Professional Core*	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Mechatronics Engineering*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning
CLR-1 :	*Utilize fundamental knowledge on fluid power, working of pneumatic and electro-pneumatic system components*	1
CLR-2 :	*Utilize working principles of pneumatic and electro-pneumatic components; design and develop fluid power circuits*	2
CLR-3 :	*Design, develop fluid power circuits for various applications, utilize working of hydraulic systems components*	3
CLR-4 :	*Utilize working principle of various hydraulics application circuits.*	
CLR-5 :	*Utilize programmable logic controllers and PLC programming for fluid power system control.*	
CLR-6 :	*Utilize fluid power system components and design and control fluid power circuits for automation applications*	

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	*Recognize the use of fluid power systems, and identify various pneumatic and electro-pneumatic components*	*2*	*80*	*75*
CLO-2 :	*Identify various pneumatic and electro-pneumatic components and design fluid power circuit for a given application*	*3*	*80*	*75*
CLO-3 :	*Design fluid power circuit for a given application and understand the working of various hydraulic components.*	*3*	*75*	*70*
CLO-4 :	*Apply hydraulic components, diagnose faults and precautions to be followed in fluid power systems.*	*3*	*75*	*70*
CLO-5 :	*Establish programming control using PLC for fluid power systems.*	*3*	*75*	*70*
CLO-6 :	*Design, develop and control fluid power systems for various applications.*	*3*	*75*	*70*

Program Learning Outcomes (PLO)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1	*H*	*L*	*L*	*L*	*M*	*L*	-	-	-	-	-	*L*	*L*	*M*	*L*
CLO-2	*H*	*H*	*H*	*H*	*M*	*L*	-	-	*M*	-	*M*	*M*	*M*	*M*	*M*
CLO-3	*H*	*H*	*H*	*H*	*M*	*L*	*L*	-	*M*	-	*M*	*M*	*M*	*M*	*M*
CLO-4	*H*	*M*	*M*	*M*	*M*	*L*	*L*	-	-	-	*M*	*L*	*L*	*M*	*M*
CLO-5	*H*	*H*	*M*	*M*	*M*	*L*	-	-	*M*	-	*M*	*M*	*M*	*M*	*H*
CLO-6	*H*	*H*	*M*	*M*	*M*	*L*	*L*	-	*M*	-	*M*	*M*	*M*	*M*	*M*

		Introduction to Pneumatics and Electro-pneumatics	Pneumatics and Electro-Pneumatics Components, Design of Circuits	Design of Circuits Intoductions to Hydraulics	Hydraulics and Electrohydraulic components and circuits	Programmable Logic Controllers
Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Introduction to Fluid Power System, Physics of Fluid Power System*	*Flow Control Valves and their functions*	*Cascading Electro-Pneumatic Circuit - Two Groups in Two Cylinder Sequential Control*	*Synchronization Circuits*	*Introduction to Programmable Logic Controllers (PLC)*
	SLO-2	*Advantages, Applications, Comparison of Pneumatic and Hydraulic Systems*	*Simple and Pressure Compensated Flow Control Valve*	*Cascading Electro-Pneumatic Circuit - Two Groups, Three-Cylinder Sequential-Control*	*Conditions for Synchronization*	*Advantages and Applications of PLC*
S-2	SLO-1	*Introduction to Pneumatic Components, Rotary Compressor - Construction and Principle of Operation*	*Non – Return Valves: Check Valve, Pilot Operated Check Valve*	*Cascading Pneumatic Circuit: Three Groups, Three-Cylinder Sequential Control*	*Hydraulic Accessories- Filters, Seals*	*Parts of PLC*
	SLO-2	*Reciprocating Compressors -Construction and Principle of Operation*	*Speed Control Circuits*	*Cascading Pneumatic Circuit: Three Groups, Three-Cylinder Sequential Control*	*Simple Pressure Relief Valve and Compound Pressure Relief Valve*	*Operation of PLC, Architecture of PLC*
S-3	SLO-1	*Air Treatment, Air Dryer*	*Logical Valves – Dual Pressure Valve, Shuttle Valve*	*Cascading Electro-Pneumatic Circuit - Three Groups, Three Cylinder Sequential Control*	*Sequence valve with application circuit*	*Introduction to PLC Programming Techniques*
	SLO-2	*FRL – Filter, Regulator and Lubricator*	*Pnuematic circuits using logical valves*	*Cascading Electro-Pneumatic Circuit - Three Groups, Three Cylinder Sequential Control*	*Pressure reducing valve with applicaton circuit*	*Introduction to ladder logic programming*

S 4-5	SLO-1	*Lab 1: Introduction to Symbolic Representation of Pneumatic Components*	*Lab 4: Speed Control Circuits*	*Lab 7: Pneumatic, Electro-pneumatic Implementation of Two Cylinder Cascading Circuit*	*Lab 10: Timer and Counter Based Electro-Pneumatic Control Circuits*	*Lab 13: Introduction to PLC and Ladder Logic Programming Software*
	SLO-2					
S-6	SLO-1	*Pneumatic Actuators, Linear, Rotary and Semi Rotary Type*	*Quick Exhaust Valve, Time Delay Valve*	*Timer Based Control of Pneumatic Cylinder*	*Pressure unloading and counter balance valve*	*Ladder Logic Program -Implementation of Logic Gates*
	SLO-2	*Cushioning in Cylinders*	*Pneumatic Circuits using Quick Exhaust Valve, Time Delay Valve*	*Counter Based Control of Pneumatic Cylinder*	*Pressure unloading and counter balance application circuit*	*Ladder Logic Program -Implementation of Start/Stop Operation and Latching*
S-7	SLO-1	*Special Cylinders*	*Introduction to Sequential Control*	*Discussion on Different Pneumatic and Electro-pneumatic Circuit Implementation*	*Accumulators – Working Principle and Types*	*Ladder Logic Program – Continuous Reciprocation Circuits*
	SLO-2	*2/2, 3/2, 5/2, 5/3 Direction Control Valves-Construction and Principle of Operation*	*Pneumatic Circuit - Two and Three Cylinder Sequential Control*	*Selection of Pneumatic Components*	*Application Circuits of Accumulator*	*Ladder Logic Program – Sequential Circuit Implementation*
S-8	SLO-1	*Direct and Indirect Control of Single Acting Cylinder*	*Electro-pneumatic Circuit - Two Cylinder Sequential Control*	*Introduction to Hydraulic Components*	*Proportional Valve – Working Principle and Control*	*Ladder Logic Program – Sequential Circuit Implementation*
	SLO-2	*Direct and Indirect Control of Double Acting Cylinder*	*Electro-pneumatic Circuit - Two Cylinder Sequential Control*	*Fluids for Hydraulic Systems*	*Force and Torque Proportional Control*	*Ladder Logic Program – Pneumatic Application*
S 9-10	SLO-1	*Lab 2: Direct and Indirect Control of Single acting and Double acting Cylinder*	*Lab 5: Pneumatic Implementation of Two Cylinder Sequential Control Circuit*	*Lab 8: Pneumatic Implementation of Three Cylinder Cascading Circuit*	*Lab 11: Hydraulic Synchronization Circuits*	*Lab 14: Developing PLC Program for Sequential Control of Pneumatic Cylinder*
	SLO-2					
S-11	SLO-1	*Introduction to Electro-pneumatics*	*Electro-pneumatic Circuit - Three Cylinder Sequential Control*	*Gear Pumps*	*Servo Valve – Working Principle and Types*	*Interlocks in PLC*
	SLO-2	*Electro-pneumatic Components – Electrical Switches and Solenoid*	*Electro-pneumatic Circuit - Three Cylinder Sequential Control*	*Vane Pumps*	*Flapper Type, Jet Pipe, Electro Hydraulic Servo Valves*	*Ladder Logic Program – Interlocking*
S-12	SLO-1	*Construction and Working Principle of Relays*	*Circuits with Overlapping Signals*	*Piston Pumps*	*Design, Selection of Components of Hydraulic Press, Hydraulic Machine Tools*	*Timers in PLC*
	SLO-2	*Timers and Counters*	*Steps to Solve Signal Overlapping Problem using Cascading Technique*	*Pump Performance, Characteristics and Selection*	*Design and Selection of Components of Articulated Mechanisms*	*Counters in PLC*
S-13	SLO-1	*Continuous Reciprocation of Single acting and Double Acting Cylinder – Pneumatic Implementation*	*Cascading Pneumatic Circuit - Two Groups in Two Cylinder Sequential Control*	*Direction Control Valves 3/2, 4/2*	*Fault Diagnostics in Fluid Power Circuits*	*Ladder Logic Program – Implementation of Timer and Counter Based Applications*
	SLO-2	*Continuous Reciprocation of Single acting and Double Acting Cylinder – Electro Pneumatic Implementation*	*Cascading Pneumatic Circuit - Two Groups in Three Cylinder Sequential Control*	*4/3 DCV – Different Center Positions*	*Safety and Emergency Mandrels in Hydraulic and Pneumatic Systems*	*Summary of the Course discussion*
S 14-15	SLO-1	*Lab 3: Continuous Reciprocation of Single acting and Double acting Cylinder*	*Lab 6: Electro-pneumatic Implementation of Two Cylinder Sequential Control Circuit*	*Lab 9: Electro-pneumatic Implementation of Three Cylinder Cascading Circuit*	*Lab 12: Developing Automation Solution for Industrial Application using Sensors*	*Lab 15: Model Practical Examination*
	SLO-2					

Learning Resources	1. *Anthony Esposito, Fluid Power with applications, 7th ed., Prentice Hall, 2014* 2. *FESTO, Fundamentals of Pneumatics, Vol I, II, III.* 3. *Majumdar .S.R., Oil Hydraulics: Principle and Maintenance, Tata McGraw Hill Education, 2012*	4. *Andrew Parr, Hydraulics and pneumatics, Jaico Publishing House, 2006* 5. *Frank D. Petrezulla, Programmable Logic Controller, 4th ed., McGraw Hill Education, 2011* 6. *Laboratory manual for Fluid Power System and Automation, SRMIST.*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (20%)		CLA – 2 (30%)		CLA – 3 (30%)		CLA – 4 (20%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
r. Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Harish Nachnani, National Sales Manager, Festo India(P) Ltd, harish.nachnani@festo.com	*1. Dr. P. Karthikeyan, MIT campus, Anna university, pkarthikeyan@annauniv.edu*	*1. Mr. Sanjay Kumar Kar, SRMIST*
2. Mr.Girish Joshi, Senior Manager, BoschRexroth ltd, joshi.gs@boschrexroth.co.in	*2. Dr.B.Mohan, Professor, Anna University, mohanb@mitindia.edu*	*2. Ms. G. Madhumitha SRMIST*

Course Code	18MHC106T	Course Name	KINEMATICS AND DYNAMICS OF RIGID BODIES AND MECHANISMS	Course Category	C	*Professional Core*	L	T	P	C
							3	1	0	4

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Mechatronics Engineering*	Data Book / Codes/Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	*Utilize the concept of machines, mechanisms and flywheel*			
CLR-2 :	*Utilize knowledge on the performance of cams, gyroscope*			
CLR-3 :	*Impart knowledge on the performance of gears and gear trains*			
CLR-4 :	*Explore the undesirable effects of unbalanced force in engines and its remedies*			
CLR-5 :	*Utilize knowledge in vibratory systems*			
CLR-6 :	*Utilize various laws governing rigid body motions, vibration characteristics and balancing of mechanical machines*			

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)													
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Comprehend the concept of machines, mechanisms and flywheel.*	*1*	*85*	*80*	*H*	*L*	*-*	*H*	*M*	*-*	*L*	*L*	*M*	*-*	*-*	*-*	*M*	*-*	*-*
CLO-2 :	*Analyze the performance of cams, gyroscope*	*2*	*85*	*80*	*H*	*H*	*-*	*H*	*M*	*-*	*L*	*L*	*M*	*-*	*-*	*-*	*-*	*-*	*-*
CLO-3 :	*Analyze the performance of gears and gear trains.*	*2*	*85*	*80*	*H*	*H*	*-*	*H*	*M*	*-*	*L*	*L*	*M*	*-*	*-*	*-*	*-*	*-*	*-*
CLO-4 :	*Utilize the knowledge of undesirable effects of unbalanced force in engines*	*2*	*85*	*80*	*H*	*H*	*-*	*H*	*M*	*-*	*L*	*L*	*M*	*-*	*-*	*-*	*-*	*-*	*-*
CLO-5 :	*Interpret and solve problems in vibratory systems and analyze the effects*	*2*	*85*	*80*	*H*	*H*	*-*	*H*	*M*	*-*	*L*	*L*	*M*	*-*	*-*	*-*	*-*	*-*	*-*
CLO-6 :	*Implement various laws governing rigid body motions, vibration characteristics and balancing of mechanical machines*	*2*	*85*	*80*	*H*	*H*	*-*	*H*	*M*	*-*	*L*	*L*	*M*	*-*	*-*	*-*	*-*	*-*	*-*

		Basic Elements of Mechanisms	Cams and Gyroscope	Gears and Gear trains	Balancing of masses	Vibrations
Duration (hour)		12	12	12	12	12
S-1	SLO-1	*Introduction to kinematic links, pairs, chain, machine and structure*	*Classifications of cam and follower*	*Fundamentals of toothed gearing*	*Introduction to balancing of masses*	*Introduction to Vibration*
	SLO-2	*Degrees of freedom(DOF)*	*Classifications of cam and follower*	*Types of gear*	*static and dynamic mass balancing*	*Types of vibration*
S-2	SLO-1	*Grashoff's law, Kutzback's criterion for planar mechanism*	*Construction of cam profile when the follower moves with uniform velocity and simple harmonic motion*	*Gear nomenclature*	*Balancing of several masses rotating in single plane.*	*Longitudinal, transverse vibration*
	SLO-2	*Kinematic inversions of four bar mechanism and slider crank mechanism and its kinematic inversions*				
S-3	SLO-1	*Modelling Simulation of Crank and slotter lever mechanism*	*Construction of cam profile when the follower moves with uniform acceleration and retardation*	*Law of gearing, forms of teeth*	*Balancing of several masses rotating in single plane.*	*Dunkerley's method.*
	SLO-2	*Modelling Simulation of Whitworth quick return mechanism*		*Length of path of contact*		*Critical speed of shafts*
S-4	SLO-1	*Practice 1: Problems on DOF of Planar mechanisms, crank and slotted lever mechanism*	*Practice 4: Problems on construction of cam profile profile when the follower moves with uniform velocity and simple harmonic motion*	*Practice 7: Problems on Length of path of contact*	*Practice 10: Problems on Balancing of several masses rotating in single plane.*	*Practice 13: Problems on Longitudinal, transverse vibrations*
	SLO-2					
S-5	SLO-1	*Turning moment diagram of a single cylinder engine*	*Construction of cam profile when the follower moves in cycloidal motion*	*Length of arc of contact*	*Balancing of several masses rotating in different planes.*	Viscous damping
	SLO-2			*Contact ratio, interference*		damping factor

S-6	SLO-1	*Turning moment diagram of a multi cylinder engine*	*Gyroscope: Forces and couples*	*Gear trains.*	*Balancing of reciprocating masses.*	*Torsional vibrations.*
	SLO-2			*Types of gear trains- simple gear train*		
S-7	SLO-1	*Fluctuation of energy, coefficient of fluctuation of energy*	*Effect of gyroscopic couple in aeroplanes*	*Compound gear train.*	*Balancing of single cylinder engine.*	*Single and two rotor systems*
	SLO-2			*Reverted gear train.*		
S-8	SLO-1	*Practice 2: Problems turning moment diagram for single cylinder and multi cylinder*	*Practice 5: Problems on construction of cam profile profile when the follower moves in cycloidal motion*	*Practice 8: Problems on simple, compound and reverted gear trains*	*Practice 11: Problems on Balancing of single cylinder engine*	*Practice 14: Problems on Dunkerley method and critical speed of shaft*
	SLO-2					
S-9	SLO-1	*Coefficient of Fluctuation of speed*	*Stability of a four wheel drive moving in a curved path*	*epicyclic gear train.*	*Balancing of multi cylinder inline engine.*	*Three rotor systems.*
	SLO-2					
S-10	SLO-1	*Energy stored in flywheel*	*Gyroscope: stability of two-wheel*	*Tabular method – epicyclic and reverted gear train*	*Hammer blow*	*Torsional vibrations on geared systems*
	SLO-2				*swaying couple*	
S-11	SLO-1	*Dimensions of flywheel rim.*	*Effect of gyroscopic couple in ships*	*Compound epicyclic gear train.*	*Tractive force.*	*Vibration analysis of geared systems.*
	SLO-2					
S-12	SLO-1	*Practice 3: Problems on energy stored in flywheel and flywheel rim dimensions*	*Practice 6: Problems on effect of gyroscopic couple on aeroplanes and four wheeler and two wheeler*	*Practice 9: Problems on Compound epicyclic gear train.*	*Practice 12: Problems on Balancing of multi cylinder inline engine.*	*Practice 15: Problems on two rotor system and three rotor system*
	SLO-2					

Learning Resources	1. *Ratan.S.S, Theory of Machines, 4th ed., Tata McGraw Hill, 2014* 2. *R.L. Norton, Kinematics and Dynamics of Machinery, 1st ed., Tata McGraw Hill, 2010* 3. *Sadhu singh Theory of machines, 3rd ed., Pearson, 2011* 4. *Gordon R. Pennock & Shigley J.E John J Uicker, 4th ed., Theory of machines and mechanisms, Oxford university press, 2014* 5. *R.K. Bansal, J.S. Brar, Theory of Machines, 5th ed., Lakshmi publications, 2016*	6. *Singiresu S.Rao, Mechanical Vibrations, Nem Chand and Bros, 1998* 7. *Thomas Beven, Theory of Machines, 3rd ed., CBS Publishers and Distributors, 2013* 8. *Sing.V.P, Mechanical Vibrations, Dhanpat Rai and Co., 1998* 9. *Rao.J.S., Dukkipati.R.V, Mechanism and Machine Theory, Wiley Eastern Ltd., 2006* 10. *John Hannah, Stephens.R.C, Mechanics of Machines, Viva Low Price student edition, 1999* 11. *Ghosh .A., Mallick.A.K, Theory of Mechanisms and Machines, Affiliated East - West Pvt. Ltd., 2006*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. K.Balaguru, Hindhustan Aeronautics Ltd, gurubalao7@gmail.com	*1. Dr.S. S Dash, Govt. College of Engineering Kednhhar, Orisha, munu_dash_2k@yahoo.com*	*1. Mr. J. Thiyagarajan, SRMIST*
2. Mr. M. Arun kumar Rolls-Royce India (P) Ltd., arumkumar.manickam@rolls_royce.com	*2. Dr. K. Sujatha, Dr. MGR Educational and Research Institute, drksujatha23@gmail.com*	*2.*

Course Code	18MHC107T	Course Name	SYSTEM DYNAMICS	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechatronics Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Classify and manipulate the signals with systems			
CLR-2 :	Understand the significance of Laplace transform in modeling and solving the LTI systems			
CLR-3 :	Model all possible systems and derive their transfer functions			
CLR-4 :	Determine the time domain characteristics of system and stability analysis using root locus			
CLR-5 :	Obtain the frequency response and determine stability margins for linear systems			
CLR-6 :	Impart the knowledge on modeling of systems with analysis and design			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	Understand and identify the different types of signals and systems	2	80	75	H	H	M	L	M	L	M	M	L	L	M	H	M	L	M
CLO-2 :	Importance of Laplace transform in system analysis and design	2	75	75	H	H	M	H	M	L	M	M	L	L	M	H	M	L	M
CLO-3 :	Find the transfer function of possible systems using different methods	2	75	75	H	H	H	H	M	L	L	M	L	L	M	H	M	L	M
CLO-4 :	Design a system with required specifications	3	70	70	H	H	H	H	M	L	M	M	M	L	M	H	H	L	M
CLO-5 :	Analyze a system in frequency domain and determine the margins for stability of system	3	70	70	H	H	H	H	M	L	M	M	M	L	M	H	H	L	M
CLO-6 :	Identify, analyze and design of a system for the required specifications	3	75	70	H	H	H	H	M	L	M	M	M	L	M	H	H	L	M

		Introduction to Signals and Systems	Linear Time - Invariant Systems	Modeling in S-Domain	Time Domain Analysis and Root Locus	Frequency Response Analysis
Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to Signals	Introduction to LTI systems	Transfer functions of simple mechanical systems	First order System and its specifications	Introduction to frequency response
	SLO-2	Representation of signals in continuous and discrete time	Impulse response of LTI systems	Transfer functions of simple mechanical systems	Step, ramp and impulse response analysis of first order systems	Frequency domain specifications
S-2	SLO-1	Elementary/basic Signals	Derivation of Convolution integral formula	Transfer functions of simple electrical networks	Second order system and its specifications	Correlation between time domain and frequency domain specifications
	SLO-2	Relationship among the elementary signals	Properties of convolution integral	Transfer functions of simple electrical networks	Impulse response of second order systems	Construction of Bode plot
S-3	SLO-1	Properties of signals	Properties of LTI system	Analogous systems Mechanical and electrical	Step response of second order systems	Construction of Bode plot
	SLO-2	Properties of signals	Properties of LTI system	Mechanical and Electrical analogous system	Step response of second order systems	Determination of gain and phase margins
S-4	SLO-1	Signal power and energy	Differential equation representation of systems	Transfer function of electromechanical systems	Transient response specifications of under damped systems	Problems on drawing Bode plot and determining the margins for stability
	SLO-2	Problems on properties of signal	Responses of the system in time domain	Transfer function of electromechanical systems	Time domain specifications of the under damped systems	Problems on drawing Bode plot and determining the margins for stability
S-5	SLO-1	Operations on signals	Solving differential equation in time domain	Block diagram representation of system	Steady state error for closed loop system	Determination of transfer functions from

						Bode Plot
	SLO-2	*Manipulations on the dependent and independent variables*	*Solving differential equation in time domain*	*Block diagram reduction technique rules*	*Steady state error for different types and inputs of a system with generalized error coefficients*	*Determination of transfer functions from Bode Plot*
S-6	SLO-1	*Representation of Systems*	*Introduction to Laplace transformation and region of convergence*	*Problems on Block diagram reduction*	*Stability of the system with respect to the position of poles in s plane*	*Introduction and properties of Polar Plots*
	SLO-2	*Continuous and discrete time systems*	*Laplace transform of standard functions*	*Problems on Block diagram reduction*	*Stability analysis using Routh-Hurwitz criterion*	*Gain and phase margins in Polar plot*
S-7	SLO-1	*Classification and properties of system*	*Properties of Laplace transform*	*Introduction to Signal flow graphs*	*Problems on stability checking using Routh-Hurwitz criterion*	*Problems on drawing Polar plots and determining the margins*
	SLO-2	*Classification and properties of system*	*Properties of Laplace transform*	*Relationship between block diagram and signal flow graph*	*Problems on stability checking using Routh-Hurwitz criterion*	*Problems on drawing Polar plots and determining the margins*
S-8	SLO-1	*Problems on properties of system*	*Transfer function approach for dynamic system using Laplace transform*	*Determination of transfer function using*	*Introduction of Root locus and its properties*	*Nyquist stability criterion*
	SLO-2	*Problems on properties of system*	*Poles and zeros of system in 's' plane*	*Determination of transfer function using*	*Construction of Roots locus*	*Assesment of relative stability*
S-9	SLO-1	*Properties of system which contains differential equations*	*Solving differential equation using Laplace transform*	*Problems on determining the transfer function using Mason's Gain formula*	*Problems on the construction of Root locus*	*Problems on Nyquist stability criterion*
	SLO-2	*Properties of system which contains differential equations*	*Solving differential equation using Laplace transform*	*Problems on determining the transfer function using Mason's Gain formula*	*Problems on the construction of Root locus*	*Problems on Nyquist stability criterion*

Learning Resources	1. *K Ogata, System Dynamics, 3rd ed., Prentice Hall, 1998* 2. *B P Lathi, Principles of Linear Systems and Signals, 2nd ed., Oxford University Press, 2009* 3. *Alan V Oppenheim., Alan S Willsky, Ian T. Young., Signals and Systems, Prentice Hall, 1983*	4. *J Nagrath, M Gopal, Control Systems Engineering, 5th ed., New Age International, 2007* 5. *Norman S Nise, Control Systems Engineering, 7th ed., Wiley, 2015*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. K. Karthikeyan, R&D Specialist, ABB India Ltd, Bangalore, India, sayalkarthik@yahoo.co.in	*1. Dr. Dr. B. Chittibabu, IIITDM, Kanchipuram, bcbabu@iiitdm.ac.in*	*1.Dr. M. Mohamed Rabik, SRMIST*
2. Dr. Vishal P Barde, Senior Lead Engineer, Mahindra & Mahindra, Chennai, vishalbarde@gmail.com	*2. Dr. P. Karthikeyan, MIT campus, Anna university, pkarthikeyan@annauniv.edu*	*2..Mr. S. Vasanth, SRMIST*

Course Code	18MHC108J	Course Name	DIGITAL SYSTEMS AND MICROPROCESSORS	Course Category	C	*Professional Core*	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Mechatronics Engineering*	Data Book / Codes/Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	*Perceive the fundamental Knowledge of Digital devices*			
CLR-2 :	*Know the working principle of digital circuit for performing its function*			
CLR-3 :	*Know the working nature of the sequential Devices*			
CLR-4 :	*Expose the architecture and instruction set of different microprocessors*			
CLR-5 :	*Deal with the Assembly Language program using typical instruction*			
CLR-6 :	*Gain knowledge about different peripheral interfacing Devices*			

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)													
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Understand the concept and applications of various digital circuits*	*1*	*95*	*90*	*H*	*M*	*L*	*L*	*L*	-	-	-	*L*	-	-	*L*	*M*	-	*M*
CLO-2 :	*Design the combinational and sequential circuits*	*3*	*90*	*85*	*H*	*H*	*M*	*M*	*M*	-	-	-	*M*	-	*M*	*H*	*M*	*M*	*L*
CLO-3 :	*Enlighten the architecture of microprocessors*	*1*	*85*	*80*	*H*	*L*	-	*L*	*M*	-	-	-	-	-	*L*	*M*	*M*	*H*	*M*
CLO-4 :	*Develop the assembly language programs*	*3*	*80*	*75*	*H*	*H*	*M*	*M*	*M*	-	-	-	*M*	-	*L*	*M*	*M*	*H*	*M*
CLO-5 :	*Use the processors for various applications*	*2*	*80*	*75*	*H*	*L*	*L*	*L*	*H*	-	-	-	*M*	-	*H*	*M*	*H*	*H*	*H*
CLO-6 :	*Use microprocessor with different peripherals*	*1*	*90*	*85*	*H*	*L*	*L*	*L*	*M*	-	-	-	*H*	-	*H*	*M*	*M*	*H*	*M*

		Combinational Circuit Design	Sequential circuit Design	8085 Microprocessor	8086 Microprocessor	Peripheral Interfacing
Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Introduction to logic gates, Digital logic circuits, Boolean laws and Expression*	*Introduction to Latches and Flip-Flop,*	*Introduction to microprocessors*	*Introduction, Pin Descriptions of 8086 microprocessor*	*Introduction to Data transfer Schemes*
	SLO-2	*Minterm, Maxterm, Sum of Products (SOP) and Product of Sums (POS)*	*Triggering of flip flops*	*Pin Descriptions of 8085 microprocessor*	*Modes of operation : Maximum and Minimum mode*	*Software interrupt*
S-2	SLO-1	*Boolean Laws and theorems*	*Truth Table, Characteristic Table, Excitation table and equations for flip flops*	*Architecture of 8085 microprocessor*	*Architecture of 8086 microprocessor*	*Pin Description of programmable interrupt controller-8259*
	SLO-2	*Minimization of Boolean expressions using Boolean Laws and theorems*				*Architecture of Programmable Interrupt Controller-8259*
S-3	SLO-1	*Minimization of Boolean expressions using K - map*	*Conversion of SR flip flop to any flip flop*	*Instruction set of 8085 microprocessor:Types*	*Instruction set of 8086 microprocessor*	*Pin Description of Programmable Peripheral Interface-8255*
	SLO-2		*Conversion of JK flip flop to any flip flop*	*Data Transfer Instruction Set*	*Data Transfer Instruction Set*	*Architecture of Programmable Peripheral Interface-8255*
S 4-5	SLO-1	*Lab 1: Verification of logic gates and implementation of Boolean expression*	*Lab 4: Implementation of Code converters*	*Lab 7: Implementation of Shift registers*	*Lab 10: Code conversion using 8085 microprocessor*	*Lab 13: Sorting of an array using 8086 microprocessor*
	SLO-2					
S-6	SLO-1	*Minimization of Boolean expressions using karnaugh map with don't care conditions*	*Conversion of D flip flop to any flip flop*	*Arithmetic Instruction set*	*Arithmetic Instruction set*	*Pin Description of programmable Communication Interface (USART)-8251*
	SLO-2		*Conversion of T flip flop to any flip flop*	*Logical Instruction Set*	*Logical Instruction Set*	*Architecture of programmable Communication Interface (USART)-8251*

S-7	SLO-1	*Design steps for combinational circuits.*	*Master –Slave Flip-flop*	*Branching Instruction Set*	*Branching/Program Control Instruction Set*	*Pin Description of Direct Memory Access-8257*
	SLO-2	*Design of adder and subtractor.*	*Steps to design Sequential Circuits*			*Architecture of Direct Memory Access-8257*
S-8	SLO-1	*Design of Multiplexer*	*Design of synchronous counter*	*Control Instruction set*	*String Manipulation Instruction set*	*Pin Description of programmable Interval timer - 8253*
	SLO-2	*Design of De-Multiplexer*			*Processor Control Instruction set*	*Architecture of programmable Interval timer - 8253*
S 9-10	SLO-1	*Lab 2: Implementation of Adder Subtractor, Multiplexer, Demultiplexer*	*Lab 5: Implementation of Flip flops*	*Lab 8: Study of microprocessor*	*Lab 11: Multiplication and division using 8086 microprocessor*	*Lab 14: Generation of waveforms by interfacing with 8085 microporcessor*
	SLO-2					
S-11	SLO-1	*Design of Encoder*	*Design of asynchronous sequential circuits*	*Addressing modes of 8085 microprocessors: Direct and indirect addressing mode*	*Addressing modes of 8086 microprocessors: Register and Immediate data – Group I*	*Applications: stepper motor control using 8085 microprocessor*
	SLO-2	*Design of Decoder*		*Register addressing mode register indirect addressing mode and implied addressing mode*	*Addressing mode for memory data – Group II*	
S-12	SLO-1	*Logic Diagram of Parallel binary adder/Subtractor*	*Design of Asynchronous Up, Down counter*	*Timing Diagram of 8085 microprocessor*	*Addressing mode for I/O – Group III*	*A/D and D/ A conversion using 8086 microprocessor*
	SLO-2		*Design of Asynchronous Up/ Down counter*		*Interrupts of 8086 microprocessor*	
S-13	SLO-1	*Design of code converters*	*Concept and Types of Shift Registers(Serial In Serial Out, Serial In Parallel Out, Parallel In Serial Out and Parallel In Parallel Out shift registers*	*Simple Assembly language programs using the instructions of 8085 microprocessor*	*Timing Diagram of 8086 microprocessor*	*A/D and D/ A conversion using 8085 microprocessor*
	SLO-2	*Design of magnitude comparator*			*Assembler Directives and assembly language programs of 8086microprocessor*	
S 14-15	SLO-1	*Lab 3: Implementation of encoder and decoder*	*Lab 6: Design of synchronous counter*	*Lab 9: Arithmetic operations using 8085 microprocessor*	*Lab 12: Stepper motor Interfacing using 8085 Microprocessor*	*Lab 15: Model Practical Examination*
	SLO-2					

Learning Resources	1. *M. Morris Mano, Michael D Ciletti, Digital Design, 5th ed., Pearson, 2014* 2. *Charles H.Roth, Fundamentals of Logic Design, 6th ed., Thomson Learning, 2013* 3. *Ramesh S. Gaonkar, Microprocessor Architecture. Programming and Applications with the 8085, 5th ed., Penram International Publishing (India) Private Limited. 2005*	4. *Mohammed Rafiquzzaman, Microprocessors and Microcomputer based System Design, Universal Book Stall, New Delhi, 1990* 5. *Doughlas V.Hall, Microprocessors and Interfacing, Programming and Hardware, Tata McGraw Hill, 2012* 6. *Laboratory manual for Digital Systems and Microprocessors, SRMIST*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
r. Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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2. Dr. Vishal P Barde, Senior Lead Engineer, Mahindra & Mahindra, Chennai, vishalbarde@gmail.com	*2. Dr. P. Karthikeyan, MIT campus, Anna university, pkarthikeyan@annauniv.edu*	*2..Mr. S. Vasanth, SRMIST*

ACADEMIC CURRICULA

Professional Core Courses

MECHATRONICS ENGINEERING

Regulations - 2018

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18MHC201J	Course Name	LINEAR AND DIGITAL CONTROL SYSTEMS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*System Dynamics*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Mechatronics Engineering*	Data Book / Codes/Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	*Learn the significant specifications of control systems*			
CLR-2 :	*Understand the design techniques of linear compensators and controllers*			
CLR-3 :	*Design state space based controllers and observers*			
CLR-4 :	*Practically implement state space and discrete-time controllers*			
CLR-5 :	*Simulate of control systems*			

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	*Mathematically model and design classical compensators and controllers*	*2*	*80*	*75*
CLO-2 :	*Demonstrate modeling and analysis of dynamic systems in state-space*	*3*	*80*	*75*
CLO-3 :	*Design full state feedback controllers and full order observers*	*3*	*75*	*70*
CLO-4 :	*Model, analyze and design control systems in z-domain*	*3*	*75*	*70*
CLO-5 :	*Design and simulate control systems using software tools*	*3*	*75*	*70*

Program Learning Outcomes (PLO)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*H*	*H*	*H*	*H*	*H*	-	-	-	-	-	*L*	*H*	*H*	*M*	-
CLO-2 :	*H*	*H*	*H*	*H*	*H*	-	-	-	*M*	-	-	*H*	*H*	*M*	-
CLO-3 :	*H*	*H*	*H*	*H*	*H*	-	-	-	*M*	-	*M*	*H*	*H*	*M*	-
CLO-4 :	*H*	*H*	*H*	*H*	*H*	-	-	-	*M*	-	*M*	*H*	*H*	*M*	-
CLO-5 :	*H*	*H*	*H*	*H*	*H*	-	-	-	*M*	-	*M*	*H*	*H*	*M*	-

Duration (hour)		Classical Compensators Design	PID Controller Design	State Space Modelling and Analysis	Design of State Controllers and Observers	Discrete-time Control System
		15	15	15	15	15
S-1	SLO-1	*Basic elements of automatic control systems, Classification of controlsystems*	*Introduction to active controllers*	*Concepts of state, state variables and state model*	*Concepts of controllability and observability.*	*Introduction to sampled data systems*
	SLO-2	*Review of time and frequency domain specifications of control system in a design perspective*	*Introduction to On-Off, Proportional, PI, PD and PID controllers*	*Generic state space representations for systems of different types- Linear, Nonlinear, time variant and time invariant*	*Problems and illustrations*	*Sample and holdprocess: Zero order and first order hold.*
S-2	SLO-1	*Effect of adding a pole and zero to dynamic systems*	*Transfer function , time and frequency response of PI controller*	*Derivation of linear state space model for mechanical systems*	*Full state feedback controller design- The pole placement techniques*	*Z-transform analysis of sampled data control systems*
	SLO-2	*Introduction to Compensators and types*	*Transfer function , time and frequency response of PD controller*	*Example problems*	*Examples*	*Problems*
S-3	SLO-1	*Pole zero contributions by lead, lag and lead-lag cascade compensators and their effects on compensated systems*	*Transfer function , time and frequency response of PID controller*	*Derivation of linear state space model for electrical systems*	*Full state feedback controller design using transformation method*	*Transfer function of discrete-time systems*
	SLO-2	*Electrical cascade compensating networks- Transfer function, time and frequency response*	*Effect of each term of PID controller on the response of system*	*Example problems*	*Examples*	*Performance of a sampled-datasecond order system.*
S	SLO-1					

Duration (hour)		Classical Compensators Design	PID Controller Design	State Space Modelling and Analysis	Design of State Controllers and Observers	Discrete-time Control System
		15	15	15	15	15
4-5	SLO-2	*Lab-1:Generate standard test signals: Impulse, step, ramp,parabolic, exponential and sinusoidal functions.*	*Lab-4:Root locus method: Determination of constant gain K,stability analysis*	*Lab-7:Design of controllers (PI, PD, PID) in time domain and frequency domain*	*Lab-10:Modeling in state-space: Determine state transition matrix, controllability and observability of linear systems*	*Lab-13:Discrete-time control systems: Convert a given transfer functions from analog to digital form, determine performance and stability in Z–domain.*
S-6	SLO-1	*Lead compensator design procedure using root locus- qualitative treatment preferably using software tools*	*Model based design of PI controller*	*Derivation of linear state space model for electrical systems*	*Full state feedback controller design using direct substitution method*	*Stability Analysis of discrete-time systems-Jury's stability criteria*
	SLO-2	*Example problems*	*Example- model based design of PI controller for DC motor speed control*	*Example problems*	*Examples*	*Example problems*
S-7	SLO-1	*Lag compensator design procedure using root locus- qualitative treatment preferably using software tools*	*Model based design of PD controller*	*Computation of state transition matrix, properties of statetransition matrix.*	*Full state feedback controller design using Ackerman's formula*	*Digital controller design-Direct digital design technique and conversion by transformation-introduction*
	SLO-2	*Example problems*	*Example- model based design of PD controller for DC motor position control*	*Importance of state trajectory in chaotic systems*	*Examples*	*Mapping between s-plane and z-plane-different transformation techniques to convert analog controller to digital.*
S-8	SLO-1	*Lead compensator design procedure using Bode plot- qualitative treatment preferably using software tools*	*Model based design of PID controller*	*Solution to state equations*	*Full order and reduced order observers*	*Mapping between s-plane and z-plane-different transformation techniques to convert analog controller to digital.*
	SLO-2	*Example problems*	*Example- model based design of PID controller for DC motor speed as well as position control.*	*Example problems*	*Full order observer design using different methods-Design examples*	*Examples*
S 9-10	SLO-1	*Lab-2: Derive transfer functions of electrical, mechanical and electromechanical systems*	*Lab-5:Frequency response analysis: Determine frequencydomain specifications using Bode plot*	*Lab-8:System Identification with Qube servo*	*Lab-11:Design of full state feedback controllers and full order observers.*	*Lab-14:Implement digital compensators through though transformation technique*
	SLO-2					
S-11	SLO-1	*Lag compensator design procedure using Bode plot- qualitative treatment preferably using software tools)*	*Limitations of Basic PID controller- Sensitive to Noise, Integrator wind-up problem.*	*Conversions of transfer function to state space model and vice versa.*	*Integrated full-state feedback and observer*	*Direct digital compensator design by Root locus technique*
	SLO-2	*Example problems*	*A more practical version of PID controller- it's implementation*	*Example problems*	*Examples*	*Direct digital compensator design by Root locus technique*
S-12	SLO-1	*Introduction to lead-lag compensator*	*Empirical procedure for tuning of PID gains*	*Different Canonical forms of representation of state space models*	*Case study: demonstration of integrated full state feedback & observer in simulation*	*Example problems*
	SLO-2	*Comparison- Lead vs Lag compensators, s-domain vs frequency domain design*	*Zeigler-Nichols method based on open loop and closed loop responses. Cohen- coon method*	*Example Problems*	*A case study- demonstration of integrated full state feedback & observer in simulation*	*Example problems*
S-13	SLO-1	*Limitations of passive compensators*	*Comparison between compensators and active controllers*	*Advantages and disadvantages of state space model representation*	*Introduction to optimal control systems*	*Selection of sampling rate, parameters to meet the desired performance of discrete-time control systems*
	SLO-2	*Need for active controllers*	*Limitations of PID controllers- Need for model based controllers.*	*State space model for discrete-time systems*	*Introduction to optimal control systems*	*Example problems*
S 14-15	SLO-1	*Lab-3:Determine time domain specifications for a givensystem: Transient and steady state.*	*Lab-6:Design compensators (lead, lag etc.,) in time domain and frequency domain.*	*Lab-9:Speed and position control of Qube servo*	*Lab-12: Implement Kalman filter*	*Lab-15: Implement digital compensators by direct digital method*
	SLO-2					

Learning Resources	1. *Richard C Dorf and Robert H Bishop, "Modern Control Systems", 13th edition, Pearson Education, 2016.* 2. *Norman S Nise, "Control Systems Engineering", 7th edition, Wiley, 2015.* 3. *I J Nagrath, M Gopal, "Control Systems Engineering", 5th edition, New Age International, 2007.* 4. *Benjamin C Kuo, FaridGolnaraghi, "Automatic Control Systems", 9th edition, Wiley, 2009.*	5. *K Ogata, "Modern Control Engineering", Prentice Hall, 2010.* 6. *A NagoorKani, "Control systems", RBA, 1998.* 7. *Quanser QNET Practical Control Guide.* 8. *Linear and Digital Control Systems Laboratory Manual, SRMIST.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
	Understand										
Level 2	Apply	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Analyze										
Level 3	Evaluate	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Create										
	Total	100 %		100 %		100 %		100 %		-	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1.Mr.Ganesh Ram, Intel Labs ,Bangalore, ganeshram.nandakumar.@intel.com	*1. Dr.R. Thiyagarajan, Visiting faculty, IIT Madras, thiyaguiitm@gmail.com*	*1. Mr.K.Sivanathan, SRMIST*
2. Mr. Mohammed Sagheer ,Wabco Technology Center ,India, mohammedsagheer.musthafa@wabco-auto.com	*2. Dr.PKarthikeyan, MIT,Anna University, pkarthikeyan@annauniv.edu*	*2. Ms.T.Rajalakshmi, SRMIST*

Course Code	18MHC202J	Course Name	SENSORS AND SIGNAL CONDITIONING	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*18MHC103T*	Co-requisite Courses	*Nil*	Progressive Courses	*18MHC302J,18MHE402T,18MHE428T*
Course Offering Department	*Mechatronics Engineering*	Data Book / Codes/Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	*Expose the applications of OPAMP in signal conditioning circuits*			
CLR-2 :	*Perceive the fundamental knowledge of sensors and their characteristics and know the working principle of sensors for measurement of Force, Displacement*			
CLR-3 :	*Know the working principle of sensors for measurement of Position, Distance and Acceleration*			
CLR-4 :	*Know the working principle of sensors for measurement of Pressure, Flow and Temperature*			
CLR-5 :	*Comprehend about data acquisition systems and applications of sensors*			
CLR-6 :	Gain knowledge about different sensors for physical system measurement			

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Understand the functioning of OPAMP based signal conditioning circuits*	*2*	*90*	*85*	*H*	*M*	*L*	*L*	*M*	-	-	-	-	-	-	*L*	*M*	-	*M*
CLO-2 :	*Identify the different types of sensors, their selection criteria and selection of sensors for measurement of Force and Displacement*	*3*	*90*	*80*	*H*	*M*	-	*L*	*M*	*L*	-	-	-	-	*L*	*H*	*M*	*M*	*L*
CLO-3 :	*Identify and select sensors for measurement of Position, Distance and Acceleration*	*3*	*85*	*80*	*H*	*L*	-	*L*	*M*	*L*	-	-	-	-	*L*	*M*	*M*	*H*	*M*
CLO-4 :	*Identify and select sensors for measurement of Pressure, Flow and Temperature*	*3*	*80*	*80*	*H*	*L*	-	*L*	*M*	*L*	-	-	-	-	*L*	*M*	*M*	*H*	*M*
CLO-5 :	*Understand the working of data acquisition system and applications of sensors in various fields*	*3*	*85*	*80*	*H*	*L*	*L*	*L*	*H*	*L*	-	-	-	-	*L*	*M*	*H*	*H*	*H*
CLO-6 :	*Prescribe the type of sensor to measure a specific phenomenon and appropriate signal conditioning circuit*	*2*	*85*	*80*	*H*	*L*	*L*	*L*	*M*	*L*	-	-	-	-	*L*	*M*	*M*	*H*	*M*

Duration (hour)		Signal Conditioning System	Fundamentals of Sensors, Measurement of Force and Displacement	Measurement of Position, Distance and Acceleration	Measurement of Pressure, Flow and Temperature	Data Acquisition System and Case Studies
		15	15	15	15	15
S-1	SLO-1	*Review of OPAMP*	*Introduction to Sensors and Transducers*	*Working Principle of Eddy Current Sensor*	*Piezoelectric effect*	*Elements of Data Acquisition System*
	SLO-2	*Discussion*	*Classification of Sensors According to Various Physical Quantities*	*Applications of Eddy Current Sensor*	*Working Principle and Applications of Piezoelectric Sensor*	*Elements of Data Acquisition System*
S-2	SLO-1	*Characteristics of Instrumentation Amplifier*	*Working Principle of Strain Gauge*	*Working Principle of Hall Effect Sensor*	*Construction and Working of Bourdon Tubes*	*Multichannel Data Acquisition System*
	SLO-2	*Working of Instrumentation Amplifier*	*Applications of Strain Gauge and Simple Problems*	*Applications of Hall Effect Sensor*	*Types and Applications of Bourdon Tubes*	*Multichannel Data Acquisition System*
S-3	SLO-1	*Design and Analysis of RC Active Low Pass Filter*	*Working Principle and Applications of Load Cell*	*Working Principle and Types of Infra-Red Sensors*	*Working Principle and Applications of Diaphragms*	*Multiplexing*
	SLO-2	*Design and Analysis of Integrator*	*Quarter Bridge, Half Bridge and Full Bridge Configuration of Load Cells*	*Applications of IR Sensors*	*Working Principle and Applications of Bellows*	*DE multiplexing*
S 4-5	SLO-1	*Introduction to the Lab Course Lab 1: Study of Characteristics of Instrumentation Amplifier*	*Lab 4: Study of Characteristics of Load Cell*	*Lab 7: Distance Measurement using IR Sensor*	*Lab 10: Study of Characteristics of Pressure Sensor*	*Lab 13: Introduction to PC Based Data Acquisition System*
	SLO-2					

Duration (hour)		Signal Conditioning System	Fundamentals of Sensors, Measurement of Force and Displacement	Measurement of Position, Distance and Acceleration	Measurement of Pressure, Flow and Temperature	Data Acquisition System and Case Studies
		15	15	15	15	15
S-6	SLO-1	*Design and Analysis of RC Active High Pass Filter*	*Working Principle and Applications of Potentiometer*	*Doppler Effect*	*Working Principle of Flow Sensors*	*Applications of Sensors in Bio Medical Systems*
	SLO-2	*Design and Analysis of Differentiator*	*Working Principle, Types and Applications of Capacitive Sensors*	*Working Principle and Applications of Ultrasonic Sensor*	*Hot Wire Anemometer*	*Discussion*
S-7	SLO-1	*Sampling theorem, Effect of Sampling*	*Working Principle of Magnetic Proximity Switch*	*Working Principle of SONAR*	*Working Principle of Acoustic sensors*	*Applications of Sensors in Aerospace Systems*
	SLO-2	*Quantization, Quantization Error, Digitizing*	*Applications of Magnetic Proximity Switches*	*Working Principle of RADAR*	*Applications of Acoustic sensors*	*Discussion*
S-8	SLO-1	*Aliasing, Sample and Hold Circuit*	*Working Principle of Inductive Proximity Switch*	*Working Principle and Types of Accelerometer*	*Working Principle of Thermocouple*	*Applications of Sensors in Automobile Systems*
	SLO-2	*Simple Problems*	*Applications of Inductive Proximity Switches*	*Applications of Accelerometer*	*Types and Applications of Thermocouple*	*Discussion*
S 9-10	SLO-1	*Lab 2: Study of Characteristics of Active Filters*	*Lab 5: Study of Characteristics of Potentiometer*	*Lab 8: Distance Measurement using Ultrasonic Sensor*	*Lab: 11 Study of Characteristics of Thermocouple and MEMS IC Sensor*	*Lab 14: Repeat Lab Session*
	SLO-2					
S-11	SLO-1	*ADC: Flash Type*	*Working Principle and Applications of LVDT*	*Inertial Measurement Sensor*	*Working Principle of Thermistor*	*Applications of Sensors in Automobile Systems*
	SLO-2	*ADC: Successive Approximation Type*	*Working Principle and Applications of RVDT*	*Inertial Measurement Sensor*	*Applications of Thermistor*	*Discussion*
S-12	SLO-1	*DAC: Weighted Resistor, R-2R Network*	*Static Characteristics*	*Introduction to Optical Sensors - Photo Diode, Photo Transistor, Opto-Coupler*	*Working Principle of RTD*	*Sensors in Manufacturing*
	SLO-2	*Specifications of ADC and DAC*	*Simple Problems*	*Working Principle of LIDAR*	*Applications of RTD*	*Discussion*
S-13	SLO-1	*Precision Diodes, Half Wave Precision Rectifiers*	*Dynamic Characteristics*	*Working Principle of Optical Encoders*	*Concept of Thermal Mapping*	*Summary of the Course*
	SLO-2	*Full Wave Precision Rectifiers*	*Sensor Calibration*	*Types and Applications of Optical Encoders*	*Applications of Thermal Mapping*	*Discussion*
S 14-15	SLO-1	*Lab 3: Study of Characteristics of Precision Circuits*	*Lab 6: Study of Characteristics of LVDT*	*Lab 9: Position Measurement using Optical Encoders*	*Lab: 12 Study of Characteristics of Thermistor and RTD*	*Lab 15: Model Practical Examination*
	SLO-2					

Learning Resources	1. *Roy Choudhury.D, Shail. B.Jain, "Linear Integrated Circuits", 4th edition, New Age International Publishers, 2010.* 2. *Pratranabis.D, "Principles of Industrial Instrumentation", 2nd edition, Tata McGraw Hill, 1996.* 3. *Sawhney. A.K., "Course in Mechanical Measurements and Instrumentation", DhanpatRai and Sons, 12thedition, 2001.*	4. *Pratranabis.D, "Principles of Industrial Instrumentation", 2nd edition, Tata McGraw Hill, 1996.* 5. *Paul P.L Regtien, "Sensors for Mechatronics", Elsevier publications, 1st edition, 2012.* 6. *Laboratory Manual for Sensors and Signal Conditioning, SRMIST.*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	Total	100 %		100 %		100 %		100 %		100%	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.A.Jegan, Assistant Manager, Renault – Nissan Technology and Business Centre India Private Ltd, jegan.a@rntbci.com	*1. Dr.K. Kalaichelvan, Professor, Department of Ceramic Technology, Anna University, Chennai, kalaichelvan@annauniv.edu*	*1. Ms. G. Madhumitha SRMIST*
2. Mr.R.GovardhanaGiri, Head – Atalon International, giri@atalon.in	*2. Dr. P. Karthikeyan, Assistant Professor, Department of Production Technology, Anna University-MIT Campus, Chennai, pkarthikeyan@mitindia.edu*	*2. Mr. J. Thiyagarajan SRMIST*

Course Code	18MHC203J	Course Name	MACHINE DESIGN	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18MHC101J	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechatronics Engineering	Data Book / Codes/Standards		Approved design data book	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	*Analyze stress, strain in mechanical components, quantify failure modes in mechanical parts for various load conditions.*			
CLR-2 :	*formulate, design and identify torque elements.*			
CLR-3 :	*estimate the life of sliding and rolling contact bearings.*			
CLR-4 :	*analyze the gear failure modes, evaluate forces and stresses within a gear system.*			
CLR-5 :	*select flexible drive systems and design for light, medium and heavy duty applications.*			
CLR-6 :	*design, analyze, and select the suitable components for any particular engineering applications.*			

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*design basic mechanical components by considering the stress induced due to different kinds of load.*	*3*	*85*	*80*	*H*	*H*	*M*	*M*	*M*	*L*	*M*	*M*	*H*	*M*	*L*	*H*	*M*	*M*	*M*
CLO-2 :	*select suitable shaft and coupling for the particular engineering applications.*	*3*	*85*	*80*	*H*	*H*	*H*	*M*	*M*	*L*	*M*	*M*	*H*	*M*	*L*	*H*	*M*	*M*	*M*
CLO-3 :	*analyze and select bearing and lubricants for various engineering applications.*	*3*	*85*	*80*	*H*	*H*	*M*	*M*	*M*	*L*	*M*	*M*	*H*	*M*	*L*	*H*	*M*	*M*	*M*
CLO-4 :	*design and analyze various simple gear trains for various power transmission applications.*	*3*	*85*	*80*	*H*	*H*	*M*	*M*	*M*	*L*	*M*	*M*	*H*	*M*	*L*	*H*	*M*	*M*	*M*
CLO-5 :	*design and select suitable flexible drive system for power transmission applications.*	*3*	*85*	*80*	*H*	*H*	*M*	*M*	*M*	*L*	*M*	*M*	*H*	*M*	*L*	*H*	*M*	*M*	*M*
CLO-6 :	*design and analyze the fundamental elements of machine component.*	*3*	*85*	*80*	*H*	*H*	*H*	*H*	*H*	*L*	*M*	*M*	*H*	*M*	*L*	*H*	*M*	*M*	*M*

Duration (hour)		Stresses In Machine Parts	Design of Shafts, Springs And Couplings	Design Of Bearings	Design of Gears	Design of Flexible Drives
		15	15	15	15	15
S-1	SLO-1	*Introduction to the design process, Materials Selection and its Properties, Preferred Numbers, Fits and Tolerances*	*Introduction to Shafts and Types of Transmission Shafts, Shaft materials*	*Introduction to Bearings, Types of Rolling Contact Bearings*	*Introduction to Mechanical Drives, Types of Gears, Gear materials, Gear Nomenclature*	*Types of Flexible Drives, Belt Materials and Constructions*
	SLO-2	*Equilibrium and Free Body Diagram*	*Shaft Layouts and Shaft design for stress*	*Selection of Bearing Type, Static and Dynamic Load Carrying capacity, Equivalent Bearing Load*	*Contact Ratio, Interference, Undercutting and Backlash*	*Mechanics of Belt Drives, Selection of Belt Drives, Belt Tension*
S-2	SLO-1	*Direct, Bending and torsional stresses*	*Practice 11: Problems on Design of Shaft on Strength basis*	*Load –Life Relationship, Selection of Ball Bearing Life*	*Force Analysis-Spur Gear*	*Flat Belt Drive*
	SLO-2	*Practice1: Problems on Bending and Torsional stresses*		*Practice 15: Problems on Single Row Deep Groove Ball Bearing*	*Design of spur gear based on Lewis and Buckingham equations*	*Practice 28: Problems on Design of Flat Belt Drive*
S-3	SLO-1	*Stresses for Various Load Combinations*	*Practice 12 Problems on Design of Shaft on Torsional Rigidity basis*	*Selection of Taper Roller Bearings*	*Practice 22: Problems on Spur Gear Design Based on Lewis and Buckingham Equations*	*V- Belt Drive*
	SLO-2	*Practice 2:Problems on Various Machine Members Subjected to Various Load Combinations*		*Practice 16: Problems on Taper Roller Bearings*		*Practice 29: Problems on Design of V- Belt Drive*
S-4	SLO-1	*Eccentric Loading*	*Design of Hallow Shaft*	*Design for Cyclic Loads and Speeds*	*Practice 23: Problems on Spur Gear Design Based on Lewis and Buckingham Equations*	*Practice 30: Problems on Design of V- Belt Drive*
	SLO-2	*Practice 3:Problems on Various Machine Members Subjected to Eccentric Loading*	*Practice 13: Problems on Design of Hallow Shaft on Strength and Torsional Rigidity basis*	*Practice 17: Design of Ball Bearings subjected to Cyclic Loads and Speeds*		

Duration (hour)		Stresses In Machine Parts	Design of Shafts, Springs And Couplings	Design Of Bearings	Design of Gears	Design of Flexible Drives
		15	15	15	15	15
S-5	SLO-1	*Lab 1: Part Modelling of a Mechanical Component using CAD tool*	*Lab 4: Part Modelling of a Universal Coupling and its Assembly using CAD tool*	*Lab 7: Part Modelling of a Screw Jackand its Assembly using CAD tool*	*Lab 10: Stress Analysis of an Axis-Symmetric Component using ANSYS*	*Lab 13: Convective Heat Transfer Analysis of a 2D Component using ANSYS*
	SLO-2					
S-6	SLO-1	*Factor of safety for Brittle and Ductile Materials*	*Spring Materials,Stresses in Helical Springs*	*Types of Lubrication, Viscosity Index, Petroff's Equation*	*Helical Gear Nomenclature*	*Chain Drive: Types, Failures, Designation*
	SLO-2	*Significance of Factor of Safety in Machine Design*	*Curvature Effect, Deflection, Compression Springs, Stability*	*Stable and Thick-Film Lubrication*	*Force Analysis- Helical Gear*	*Selection of Chain Drive, Chain Lubrication*
S-7	SLO-1	*Theories of failure*	*Helical Compression Spring Design Against Static Load*	*Design Considerations*	*Design of helical gear based on modified Lewis equations*	*Design of Chain Drive*
	SLO-2	*Practice 4: Problems on Theory of failure*	*Practice 14: Problems on Design of Helical Spring Subjected to Static Load*	*Hydrostatic Step Bearing and its Energy Losses*		*Practice 31: Problems on Design of Chain Drive to run a Compressor*
S-8	SLO-1	*Introduction to Fracture Mechanics, and Fatigue in Metals*	*Helical Compression Spring Design- Trial and Error method*	*Practice 18: Problems on Hydrostatic Thrust Bearings*	*Practice 24: Problems onHelical Gear Design Based on Lewis Equations*	*Practice 32: Problems on Design of Chain Drive Power Transmission Shaft Applications*
	SLO-2	*S-N Curve, Fatigue Strength and the Endurance Limit*	*Practice 14: Problems on Design of Helical Spring based on Trial and Error Method*			
S-9	SLO-1	*Endurance Limit Modifying Factors, Stress Concentration and Notch Sensitivity*	*Helical Compression Spring Design Against Fatigue Load*	*Practice 19: Problems on Hydrostatic Step Bearings*	*Practice 25: Problems onHelical Gear Design Based on Modified Lewis Equations*	*Practice 33: Problems on Design of Chain Drive for Drilling Machine Applications*
	SLO-2	*Practice 6: Problems on Stress Concentration Factors*	*Practice 14: Problems on Design of Helical Spring Subjected to Fatigue Load*			
S-10	SLO-1	*Lab 2: Part Modelling of a Mechanical Component using CAD tool*	*Lab 5: Part Modelling of a Plummer Blockand its Assembly using CAD tool*	*Lab 8: Stress Analysis of Truss using ANSYS*	*Lab 11: Stress Analysis of Beams (Cantilever, Simply supported, Fixed ends) using ANSYS*	*Lab 14: Modal analysis of Spring-Mass system using ANSYS*
	SLO-2					
S-11	SLO-1	*Practice 7: Infinite Life for Machine Member Subjected to Reversed Load*	*Design of Keys*	*Hydrodynamic Theory*	*Bevel Gear and Its Types*	*Wire Rope - Types, Construction, Lays of Wire Rope*
	SLO-2	*Practice 8: finite Life for Machine Member Subjected to Reversed Load*	*Practice 15: Problems on Design of Keys*	*Sommerfeld Number, Raimondi and Boyd method*	*Bevel Gear Nomenclature*	*Failures in Wire Rope*
S-12	SLO-1	*Soderberg and Goodman lines, Modified Goodman Diagram,*	*Design of rigidFlange Coupling*	*Temperature Rise, Bearing Construction, Bearing Materials*	*Force Analysis- Bevel Gear*	*Selection of Wire Rope, Stresses in Wire Rope*
	SLO-2	*Design for Variable Loading*	*Practice 16: Problems on Flange Coupling*	*Selection of Lubricants , Bearing failures*	*Design of bevel gear based on Lewis and Buckingham equations.*	*Design of a Wire RopeDrive for Crane Applications*
S-13	SLO-1	*Practice 9: Problems on Infinite Life for Machine Member Subjected to Fluctuating Load*	*Design of Flexible Flange Coupling*	*Practice 20: Problems on Hydrodynamic Bearings*	*Practice 26: Problems on Bevel Gear Design Based on Lewis and Buckingham Equations*	*Practice 34: Problems on Expected life of Wire Rope under Dynamic Conditions*
	SLO-2		*Practice 16: Problems on Flexible Bushed Pin Flange Coupling*			
S-14	SLO-1	*Practice 10: Problems on Finite Life for Machine Member Subjected to Fluctuating Load*	*Practice 17: Problems on Flexible Bushed Pin Flange Couplings*	*Practice 21: Problems on Hydrodynamic Bearings*	*Practice 27: Problems on Bevel Gear Design Based on Lewis and Buckingham Equations*	*Practice 35: Problems on Factor of Safety of Wire Rope under Static Conditions*
	SLO-2					
S-15	SLO-1	*Lab 3: Part Modelling of a Flange Coupling and its Assembly using CAD tool*	*Lab 6: Part Modelling of a Knuckle Joint and its Assembly using CAD tool*	*Lab 9: Stress Analysis of a Plate with a Circular hole using ANSYS*	*Lab 12: Conductive Heat Transfer Analysis of 2D Component using ANSYS*	*Lab 15: Model Practical Exam*
	SLO-2					

Learning Resources	1. *Bhandari.V.B, "Design of Machine Elements", 3rd ed.,, Tata McGraw-Hill , 2010.* 2. *Robert L. Norton, "Machine Design: An Integrated Approach", 5th ed., Prentice Hall, 2013.* 3. *PSG, "Design Data" [Data Book Of Engineers], KalaikathirAchagam, 2016.* 4. *CAD Laboratory Manual.*	5. *Merhyle Franklin Spotts, Terry E. Shoup and Hornberger.L.E, "Design of Machine Elements", 8th ed.,, Prentice Hall,2003* 6. *Joseph Shigley and Charles Mischke, "Standard Handbook of Machine Design", 3rd ed., Tata McGraw Hill, 2004.* 7. *Richard G.Budynas, J.KeithNisbett, "Shigley's Mechanical Engineering Design", 10th ed., Tata McGraw-Hill , 2015.*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	Total	100 %		100 %		100 %		100 %		100%	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Kesavan Raja Ramasamy, Schlumberger, RKRaja@slb.com	*1. Dr.L.Ranganathan, Jeppiaar Engineering College, Chennai, ranganathanl1975@gmail.com*	*1. Mr.M.Chandrasekaran, SRMIST*
2. Mr. S.Jagadeeswaran, Renault Nissan Technology and Business Centre, jagadeeswaran.selvamani@rntbci.com	*2. Dr.K.Ramanathan, AlagappaChettiar Government college of Engineering and Technology, ramsananthi@gmail.com*	*2. Mr.S.M.Vignesh, SRMIST*

Course Code	18MHC204T	Course Name	POWER ELECTRONICS AND DRIVES	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*18MHC102T, 18MHC103T*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Mechatronics Engineering*	Data Book / Codes/Standards		-	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	*Identify different power semiconductor devices and utilize them in different converter circuits*			
CLR-2 :	*Utilise single phase and three phase converters and Choppers*			
CLR-3 :	*Utilise single phase and three phase inverters, AC Voltage regulators and cycloconverters*			
CLR-4 :	*Apply converters and choppers to drive DC motors*			
CLR-5 :	*Apply Inverters, voltage Regulators and cycloconverters to drive AC motors*			
CLR-6 :	*Utilise Power Semiconductor devices for converter circuits, operate DC and AC drives using converters*			

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Analyze various power semiconductor devices used in Power converters*	*3*	*75*	*70*	*H*	*-*	*H*	*L*	*M*	*-*	*M*	*M*	*M*	*M*	*-*	*M*	*-*	*-*	*-*
CLO-2 :	*Identify working principle of controlled Rectifiers and Choppers*	*3*	*75*	*70*	*H*	*M*	*H*	*H*	*M*	*-*	*M*	*M*	*M*	*M*	*-*	*M*	*-*	*-*	*-*
CLO-3 :	*Identify working principle of Inverters and Cycloconverters*	*3*	*75*	*70*	*H*	*M*	*H*	*H*	*M*	*-*	*M*	*M*	*M*	*M*	*-*	*M*	*-*	*-*	*-*
CLO-4 :	*Operate DC drives using controlled rectifiers and choppers*	*3*	*75*	*70*	*H*	*-*	*M*	*H*	*M*	*-*	*M*	*M*	*M*	*M*	*-*	*M*	*-*	*-*	*-*
CLO-5 :	*Operate AC drives using Inverters and Cycloconverters*	*3*	*75*	*70*	*H*	*-*	*M*	*H*	*M*	*-*	*M*	*M*	*M*	*M*	*-*	*M*	*-*	*-*	*-*
CLO-6 :	*Identify power semiconductor devices, controlled rectifiers, choppers, inverters, cycloconverters for operating electric drives.*	*3*	*75*	*70*	*-*	*-*	*M*	*M*	*M*	*-*	*M*	*M*	*M*	*M*	*-*	*M*	*-*	*-*	*-*

Duration (hour)		Semiconductor Devices	Controlled Rectifiers and Choppers	Inverters and AC Chopper	DC Drives	AC Drives
		9	9	9	9	9
S-1	SLO-1	*Introduction to power semiconductor devices.*	*Introduction to controlled rectifiers*	*Introduction to inverters*	*Drives: Introduction*	*Induction motor fundamentals*
	SLO-2	*Basic structure and operation of power diode, Types of power diode*	*Types of controlled rectifiers*	*Types of inverters.*	*Electric Drives: Classification*	*Types of Induction motor*
S-2	SLO-1	*Basic structure and operation of power transistor*	*Operation of single phase fully controlled rectifier with R load*	*Operation of 1- phase voltage source inverter.*	*Classes of Duty*	*Speed control of Induction motor : Types*
	SLO-2	*Basic structure and operation of SCR*	*Operation of single phase fully controlled rectifier with RL load*		*Fundamentals of DC motor*	*Stator voltage control.*
S-3	SLO-1	*Characteristics and applications of SCR*	*Operation of single phase fully controlled rectifier with RLE load*	*Operation of 3 - phase voltage source inverter:180° mode VSI*	*Speed control of DC motor : Armature control*	*Variable frequency control.*
	SLO-2	*Basic structure and operation of GTO*	*Operation of single phase half controlled rectifier with RLE load*		*Speed control of DC motor: Field control.*	*VSI fed Induction motor drive*
S-4	SLO-1	*Basic structure and operation of TRIAC.*	*Operation of three phase half wave controlled rectifier with R load for continuous current.*	*Operation of 3 - phase voltage source inverter: 120° mode*	*Operation of Ward Leonard drives.*	*Rotor resistance control.*
	SLO-2	*Characteristics and applications of TRIAC.*	*Operation of three phase fully controlled rectifier with R load for continuous current.*	*Operation of 3 - phase current source inverter*		*Static Rotor resistance control*

Duration (hour)		Semiconductor Devices	Controlled Rectifiers and Choppers	Inverters and AC Chopper	DC Drives	AC Drives
		9	9	9	9	9
S-5	SLO-1	*Basic structure and operation of MOSFET*	*Operation of three phase fully controlled rectifier with RL load for continuous current.*	*Types of ac voltage control: Phase control.*	*Converter fed DC drive: Types, Quadrant operation*	*Slip power recovery scheme:StaticKramers Scheme*
	SLO-2	*Characteristics and applications of MOSFET*	*Dual Converter*	*Types of ac voltage control: Integrated cycle control.*	*Fully controlled converter fed drive*	*StaticScherbius Scheme*
S-6	SLO-1	*Basic structure and operation of IGBT Characteristics and applications of IGBT*	*Operation of choppers. Classification of choppers Control strategies: Methods and Operation*	*Operation of 1- phase voltage regulator*	*Semi-converter controlled converter fed drive Speed torque characteristics*	*Fundamentals of synchronous motor Types of synchronous motor*
	SLO-2					
S-7	SLO-1	*Triggering methods for SCR*	*Operation of A, B types of chopper. Operation of C type of chopper.*	*Operation of 3 - phase AC voltage controls: With anti parallel SCR configuration, with R load operation.*	*Chopper fed DC drive: types Chopper fed DC drive: operation*	*Open loop control. Closed loop control.*
	SLO-2					
S-8	SLO-1	*Commutation techniques for SCR.*	*Operation of D type of chopper. E type of chopper.*	*1-phase cyclo–converters: Introduction 1-phase cyclo–converters: Types*	*Four quadrant operation of dc drive*	*Variable frequency control: Methods*
	SLO-2					
S-9	SLO-1	*Firing circuits of SCR: R,RC and UJT Firing circuits*	*Multiphase chopper Applications of choppers.*	*1-phase step up cyclo-converters 1-phase step down cyclo-converters*	*Closed loop control*	*Voltage source fed synchronous motor. Current source fed synchronous motor.*
	SLO-2					

Learning Resources	
1. *Bhimbra. Dr.P.S., "Power Electronics", Khanna Publishers, 2012.* 2. *Dubey.G.K., "Fundamentals of Electrical Drives", Narosa publishing house 2001.* 3. *Muhammad H. Rashid, "Power Electronics - Circuits, Devices and Applications", Prentice Hall of India, New Delhi, 2003.* 4. *Singh. M.D and Khanchandani. K.B., "Power Electronics", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2000.*	5. *Pillai.S.K., "A first course on Electrical Drives", New Age International (P)Ltd., 2012.* 6. *Dubey.G.K., "Power Semiconductor Controlled Drives", Narosa publishing house, 1995.* 7. *Dubey. G.K., "Thyristorised Power Controllers", New Age International (P) Publishers Ltd., 2002.*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*40%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	Understand										
Level 2	Apply	*40%*	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	Create										
	Total	100 %		100 %		100 %		100 %		100%	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Mr. D.Gokulakrishnan, Planning Engineer, ABB India Ltd, Oman, gokul@tlsoman.com*	1. *Dr.S.S Dash, Government College of Engineering Kednhhar, Orisha, munu_dash_2k@yahoo.com*	1. *Dr.M.Santhosh Rani, SRMIST*
2. *Mrs.T.Priya,Sr.Design Engineer, Electrical&Instrumentation,Kavin Engineering and Services Pvt Ltd, priya@kavinengg.com*	2. *Dr.M.Jagadeeshkumar,,Sri SaiRam Institute of Technology, jagadeeshkumar.eee@sairamit.edu.in*	2. *Mrs.V.Krithika, SRMIST*

Course Code	18MHC205J	Course Name	MICROCONTROLLERS AND EMBEDDED SYSTEMS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18MHC108J	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechatronics Engineering	Data Book / Codes/Standards		Nil	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Familiarize with the functionality of microcontrollers.*
CLR-2 :	*Understand the concepts of microcontroller and its applications to mechatronics systems.*
CLR-3 :	*Understand the fundamentals of embedded systems design with real time system.*
CLR-4 :	*Develop programming skill to design in embedded C.*
CLR-5 :	*Apply knowledge to real-world application.*
CLR-6 :	*To impart knowledge of embedded system and microcontroller programming.*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)													
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Demonstrate an understanding with the functionality of microcontrollers*	*2*	*85*	*80*	*H*	-	-	*M*	-	-	-	-	*H*	-	-	*H*	-	-	-
CLO-2 :	*Apply the concepts of microcontroller and its applications to mechatronics systems*	*1*	*85*	*80*	*H*	-	-	*M*	-	-	-	-	*H*	-	-	*H*	-	-	-
CLO-3 :	*Apply the fundamentals of embedded systems design with real time system.*	*1*	*85*	*80*	*H*	*H*	*H*	*H*	-	-	-	-	*H*	-	-	-	-	-	-
CLO-4 :	*Able to program and design using embedded C*	*2*	*85*	*80*	*H*	-	*H*	*H*	*M*	-	-	-	*H*	-	-	-	-	-	-
CLO-5 :	*Demonstrate the application of knowledge to real world application*	*2*	*85*	*80*	*H*	-	*H*	*H*	*M*	-	-	-	*H*	-	-	-	-	-	-
CLO-6 :	*Demonstrate an understanding on the concept of embedded system and microcontroller programming*	*2*	*85*	*80*	*H*	*H*	*H*	*H*	*M*	*L*	*M*	*L*	*H*	*L*	*M*	*H*	-	-	-

Duration (hour)		Microcontroller 8051	ARM7 Controller	Introduction to Embedded Systems	Computing Platform and Design Analysis	Real Time Operating System
		15	15	15	15	15
S-1	SLO-1	*Microcontroller 8051*	*ARM7 Controller*	*Definition, Key Elements Of An Embedded System.*	*DebuggingTechniques/ Challenges*	*Arbitration Schemes*
	SLO-2	*Architecture*	*Architecture*	*Design Metric Challenges*		*Software Architectures*
S-2	SLO-1	*Pin Description*	*Functional Description*	*Cpu Buses*	*Program Design And Analysis*	*Round Robin*
	SLO-2	*FunctionalDescription*		*Memory Devices, I/O Device*	*Components For Embedded Programs*	*Round Robin With Interrupt*
S-3	SLO-1	*Instruction Set Of 8051 Microcontroller.*	*ARM State Instruction*	*Component Interfacing*	*Model Of Programs*	*Function Queue Scheduling, Limitations Of Non-RTOS Embedded Systems*
	SLO-2	*Arithmetic Group*	*Data Transfer Instruction*	*Design With Microprocessors*	*DFG, CDFG*	*Introduction To RTOS And Its Features*
S 4-5	SLO-1	*Arithmetic Operations Using 8051*	*Arithmetic Operations Using ARM7*	*Stepper Motor Interface Using Microcontroller.*	*Keyboard Display Interface Using Microcontroller*	*Traffic Light Control Interface Using Microcontroller*
	SLO-2					
S-6	SLO-1	*Logical Group*	*Data Processing Instruction*	*Processor Technology*	*Assembly, Linking And Loading*	*Shared Data Problems*
	SLO-2	*Data Transfer Group*	*Thumb State Instruction*	*General Purpose Processors*	*Basic Compilation Techniques*	*IssuesIn SDP*
S-7	SLO-1	*Boolean Group*	*Data Transfer Instruction*	*Custom Single Purpose Processors*	*Program Optimization*	*SolutionsOf Shared Data Problem*
	SLO-2	*Branching Group*	*Data Processing Instruction*	*Application Specific Integrated Circuits*		*Semaphores – Introduction*
S-8	SLO-1	*Addressing Modes*	*Addressing Modes*	*IC Technology*	*Performance Analysis - System Level & Program Level*	*Multiple Semaphores; Reentrancy*
	SLO-2		*ARM Operating Modes*	*PLD*		*Semaphore Problems*
S 9-10	SLO-1	*Counting Odd And Even Numbers Using 8051 Microcontroller*	*Code Conversion Using ARM7*	*ADC Interfacing Using Microcontroller*	*PWM Interfacing UsingMicrocontroller*	*Repeat Session*
	SLO-2					

Duration (hour)		Microcontroller 8051	ARM7 Controller	Introduction to Embedded Systems	Computing Platform and Design Analysis	Real Time Operating System
		15	15	15	15	15
S-11	SLO-1	*Assembly Language Programming*	*Branch, SWI, PSR Instructions*	*VLSI*	*Optimization- Performance, Energy*	*Semaphores & Shared Data Problem*
	SLO-2	*Mnemonics, Op Code*	*Loading Constants, Conditional Execution*	*FPGA*	*Optimization – Power, Program Size*	*Semaphores As A Signaling Device*
S-12	SLO-1	*Programming Of 8051 Using Assembly Language*	*Programming Of ARM7Using Assembly Language*	*Design Technology*	*Program Validation*	*Operating System Services*
	SLO-2			*Hardware / Software Co-Design*	*TestingOf Program*	*Queues , Mailbox*
S-13	SLO-1	*Programming Of 8051 Using Assembly Language*	*Programming Of ARM7 Using Assembly Language*	*Integrated Development Environments*	*Interrupts*	*Pipes , Timer Functions*
	SLO-2			*Tool Chains*	*Interrupt Latency*	*Events*
S 14-15	SLO-1	*Timer/Counter Programs Using 8051 Microcontroller*	*Timer/Counter Programs Using ARM7Controller*	*DAC Interfacing Using Microcontroller*	*LED Display Using Microcontroller*	*Repeat Session*
	SLO-2					

Learning Resources	1. *Frank Vahid and Tony Givargis, "Embedded system design: A unified hardware/ software approach", Pearson Education Asia, 3rd edition, 2009.* 2. *Wayne Wolf, "Computers as components - Principles of Embedded computing system design", 2nd edition, MK Publishers.* 3. *Mazidi and Mazidi , "Intel 8051 Microcontrollers", Pearson education, India, 2006.*	4. *Steve Furber, "ARM System-on-chip Architecture", Pearson education, India, 2000.* 5. *David E.Simon , "An Embedded Software Primer", Pearson Education Asia 2001* 6. *Joseph Yiu, "The Definitive Guide to ARM Cortex Processors", 3rd edition, Newnes Publication* 7. *Microcontroller And Embedded Systems Laboratory Manual.*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	Total	100 %		100 %		100 %		100 %		100%	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.A.Rajasekar, CCG-RVP,rajasekar.a@intel.com	*1. Dr.BamaSrinivasan, Anna University, Guindy, Chennai, bama@annauniv.edu*	*1. Mrs.T.S.Rajalakshmi, SRMIST*
2. Mr. Reuben Fernandes, ATOM 360, India, wenisch@atom360.io	*2. Dr.K.Rahimunnisa, EashwariEngineering College, Chennai, krahimunnisa@gmail.com*	*2. Ms.Cross T AshaWise SRMIST*

Course code	18MHC301J	Course name	MANUFACTURING PROCESSES	Course category	P	Professional core	L	T	P	C
							3	0	2	4

Pre-requisite courses	*Nil*	Co-requisite courses	*Nil*	Progressive courses	*Nil*
Course offering department	*Mechatronics engineering*	Data book / codes/standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*understand the principle and process of different metal forming process*
CLR-2 :	*Impart knowledge on types and approaches of metal cutting process.*
CLR-3 :	*Gain knowledge in concept of computerized machine tool for metal cutting process.*
CLR-4 :	*Understand the concept of additive manufacturing process.*
CLR-5 :	*familiar in manufacturing metrology*
CLR-6 :	*implement knowledge of manufacturing processes and manufacturing metrology*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Explain the process of different metal forming process.*	*1*	*85*	*80*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	*Distinguish the types and approaches of metal cutting process.*	*1*	*85*	*80*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	*Implement the concept of computerized machine tool for metal cutting process.*	*1*	*85*	*80*	*H*	-	*H*	_	*H*	-	-	-	-	-	-	-	-	-	-
CLO-4 :	*Understand the concept of additive manufacturing process.*	*2*	*85*	*80*	*H*	-	-	*H*	-	-	*H*	-	-	-	-	-	-	-	-
CLO-5 :	*acquire knowledge on manufacturing metrology*	*2*	*85*	*80*	*H*	*H*	-	*H*	-	-	_	-	-	-	-	-	-	-	-
CLO-6 :	*impart knowledge of manufacturing processes and manufacturing metrology*	*2*	*85*	*80*	*H*	*H*	*H*	*H*	-	-	*H*	-	-	-	-	-	-	-	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Casting process: introduction*	*Introduction to metal cutting processes*	*CNC machine tools*	*Additive manufacturing: concept, types.*	*Introduction to manufacturing metrology*
	SLO-2	*Classification of casting process.*	*Cutting tools*	*NC machines*	*Fused deposition method: working principle,*	*Laser metrology and precision instruments*
S-2	SLO-1	*Mould and its types.*	*Classification: single point cutting tool nomenclature*	*DNC machines*	*Advantages, limitations, applications.*	*Types of lasers – laser in engineering metrology*
	SLO-2	*Pattern: types of pattern*	*Multi point cutting tool nomenclature*	*CNC machines: introduction*	*Selective laser sintering process*	*Metrological laser methods for applications in machine systems*
S-3	SLO-1	*Special casting techniques*	*Tool wear*	*Classification of CNC machines.*	*Working principle, advantages, limitations,*	*Interferometry applications – speckle interferometry*
	SLO-2	*Expandable mould casting*	*Tool life, Prediction of tool life*	*Constructional feature of CNC turning centre and*	*Applications.*	*Laser interferometers in manufacturing and machine tool alignment testing*
S 4-5	SLO-1	*Lab – 1: Machining of spur gear using universal milling machine.*	*Lab – 4: Manufacturing a single point cutting tool using tool and cutter grinder.*	*Lab - 6 :Multiple turning with grooving and thread cutting by applying canned cycle using CNC turning centre*	*Lab – 9: Profile cutting by applying Mirroring operation using CNC vertical machining centre.*	*Lab – 11: Profile cutting using Wire cut Electrical Discharge Machine (WEDM).*
	SLO-2					
S-6	SLO-1	*Investment casting , Shell mould casting,*	*Orthogonal and oblique cutting*	*CNCmachining centre.*	*Stereo lithography process: working principle,.*	*Introduction to co-ordinate measuring system*

Duration (hour)		15	15	15	15	15
	SLO-2	*Permanent mould casting.*	*Mechanics of orthogonal cutting using single point cutting tool*	*Open loopCNC systems, closed loop CNC systems*	*Advantages, limitations, applications*	*Co-ordinate metrology*
S-7	SLO-1	*Die casting and its types*	*Cutting forces in orthogonal cutting, merchant circle analysis.*	*CNC controllers.*	*3d printing technique: working process,*	*CMM configurations , hardware components – software*
	SLO-2	*Centrifugal casting and its types*	*Calculation of various forces involved during orthogonal cutting.*	*Structural members of CNC machines: slide ways, linear motion*	*Advantages, limitations, applications.*	*Probe sensors – displacement devices –*
S-8	SLO-1	*Defects in casting.*	*Problem solving*	*Bearings, ball screws*	*PCB manufacturing process: silicon wafer production process*	*Performance evaluations, applications*
	SLO-2	*Mechanical working of metals*	*Methods to gear generation:*	*Work holding, tool holding devices,*	*Diffusion, masking.*	*Roll of CMM in reverse engineering*
S 9-10	SLO-1	*Lab – 2: Machining of helical gear using gear hobbing machine.*	*Gear shaping*	*Lab – 7: Step turning using CNC turning centre.*	*Lab – 10: Drilling and peck drilling using CNC vertical machining centre.*	*Lab – 12: Pocketing of Linear and Circular profile using CNC vertical machining centre.*
	SLO-2					
S-11	SLO-1	*Rolling process, Mechanism, types and defects of rolling.*	*Milling*	*Automatic tool changer.*	*Photolithography technique.*	*Opto electronic devices*
	SLO-2	*Joining Process- Welding techniques-Conventional and special Techniques*	*Hobbing process.*	*Feedback devices used in machining centre*	*Etching, cleaning,*	*Ccd, on-line and in-process monitoring in production*
S-12	SLO-1	*Joining Process- Soldering and Brazing*	*Grinding: cylindrical, surface*	*fundamentals of part programming,*	*. Types of pcb: single sided, double sided,*	*Applications.*
	SLO-2	*Forging: mechanism Types, machine used for forging, defects.*	*Centreless grinding process.*	*G and m codes.*	*Multilayer pcb board*	*Image analysis and computer vision*
S-13	SLO-1	*Extrusion: mechanism, classification, defects.*	*Super finishing: lapping.*	*. Types of programming: manual part programming,*	*flexible PCB board*	*image analysis techniques*
	SLO-2	*Drawing: mechanism, tube drawing, deep drawing, defects.*	*Honing, buffing.*	*Canned cycle and subroutines.*	*Inspection of PCB boards.*	*Comparison laser scanning with vision system*
S 14-15	SLO-1	*Lab - 3 : Facing, turning and thread cutting using conventional lathe*	*Lab - 5 Finishing operation using cylindrical and surface grinding process.*	*Lab – 8 Multiple turning by applying canned cycle using CNC turning centre.*	*Lab – 13: Extra practice session.*	*Lab – 14 :Model Examination*
	SLO-2					

Learning Resources	1. *Sharma.P.C, "A textbook of Production Technology", Vol I and II, S. Chand And Company Ltd., New Delhi, 2007.* 2. *SeropeKalpakjian and Steven Schmid, "Manufacturing Engineering and Technology", Pearson Education, 7th edition, 2014.* 3. *Radhakrishnan.P, "CNC Machines", New Central Book Agency, 2000.* 4. *Pandey and H.S.Shah, "Modern Machining Process", Tata McGraw Hill Publishing Co., New Delhi, 2008.* 5. *Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", 3rd edition, World Scientific Publishers, 2010.* 6. *R. S. Khandpur"Printed Circuit Boards: Design, Fabrication, and Assembly" Tata McGraw Hill Publishing Co., New Delhi,2010.*	7. *S.K. HajraChoudry, S.K.Bose, A.K. HajraChoudry , "Elements of Workshop Technology Vol II: Machine tools", Media promoters and Publishers Pvt Ltd, 2002.* 8. *Chapman.W.A.J, "Workshop Technology" Vol. I and II, Arnold Publisher, 1996.* 9. *Elanchezhian.C, VijayaRamnath.B and Sunder Selwyn, T., Engineering Metrology, Eswar Press, Chennai, 2004.* 10. *John A. Bosch, Giddings and Lewis Dayton, Co-ordinate Measuring Machines and Systems, Marcel Dekker, Inc, 1999* 11. *ZuechNello, Understanding and Applying Machine Vision, Marcel Dekker, Inc, 2000*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Mr.K.Balaguru, Deputy manager, Hindustan Aeronautics limited, Structural Design, gurubala07@gmail.com*	1. *Dr.v. Senthilkumar , NIT Tiruchirappalli, Production department, vskumar@nitt.edu*	*1. Dr.B.K. Vinayagam, SRMIST*
2. *HariPrabhu, Junior Engineer, Indian Railways, Egmore, hpvijay5894@gmail.com*	2. *Dr. R. Sarala,AlagappaChettiar college of Engineering and Technology, Manufacturing department, r.sarala@accetedu.in, karaikudi.*	*2. Mr. J.Arivarasan, SRMIST*

Course Code	18MHC302J	Course Name	DESIGN OF MECHATRONICS SYSTEMS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Mechatronics Engineering*	Data Book / Codes/Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Understand the design challenges involved in multidisciplinary modern machines*
CLR-2 :	*Familiarize the mechatronics approach design process and its benefit*
CLR-3 :	*Understand the various simulation methods and its importance*
CLR-4 :	*Understand the importance of modeling and model based design*
CLR-5 :	*Understand and apply the mechatronics design approach for various real systems*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)													
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Familiarize with design challenges, integrated design issues associated with the multidisciplinary modern machines and systems*	*2*	*80*	*75*	*H*	*H*	*H*	*H*	*H*	*-*	*-*	*-*	*-*	*-*	*L*	*H*	*H*	*M*	*-*
CLO-2 :	*Learn the mechatronics concepts, design processes and benefits*	*3*	*80*	*75*	*H*	*H*	*H*	*H*	*H*	*-*	*-*	*-*	*M*	*-*	*-*	*H*	*H*	*M*	*-*
CLO-3 :	*Understand and apply MIL, SIL simulations and virtual prototyping*	*3*	*75*	*70*	*H*	*H*	*H*	*H*	*H*	*-*	*-*	*-*	*M*	*-*	*M*	*H*	*H*	*M*	*-*
CLO-4 :	*Learn the fundamentals of system modeling and its importance*	*3*	*75*	*70*	*H*	*H*	*H*	*H*	*H*	*-*	*-*	*-*	*M*	*-*	*M*	*H*	*H*	*M*	*-*
CLO-5 :	*Apply mechatronics design approaches in some common products development*	*3*	*75*	*70*	*H*	*H*	*H*	*H*	*H*	*-*	*-*	*-*	*M*	*-*	*M*	*H*	*H*	*M*	*-*

Duration (hour)		Introduction to mechatronic system design	Mechatronics design concepts	Model based system engineering	Case Study-1	Case Study-2
		15	15	15	15	15
S-1	SLO-1	*Definition of mechatronics*	*Significance of modeling*	*Motivation for model based system engineering (MBSE)*	*Need of model based design for the system under consideration*	*Need of model based design for the system under consideration*
	SLO-2	*Evolution of mechatronics systems*	*Example*	*System engineering process*	*Benefits of model based design*	*Benefits of model based design*
S-2	SLO-1	*Multidisciplinary nature of modern machines and their design challenges*	*Model-In-Loop(MIL) simulation*	*System lifecycle*	*Understanding the system under consideration*	*Understanding the system under consideration*
	SLO-2	*Example*	*Example*	*Types of systems*	*Mechanical and electronics description*	*Mechanical and electronics description*
S-3	SLO-1	*Traditional vs mechatronics approaches*	*Software-In-Loop(SIL) simulations*	*Modeling ,analysis and management of system requirements*	*Mathematical description of the model*	*Mathematical description of the model*
	SLO-2	*Example*	*Example*	*Modeling ,analysis and management of system requirements*	*Mathematical modeling- derivation*	*Mathematical modeling- derivation*
S 4-5	SLO-1	*Lab 1*	*Lab 4*	*Lab 7*	*Lab 10*	*Lab 13*
	SLO-2					
S-6	SLO-1	*Mechatronics design process*	*Virtual Prototyping- a critical aspect of mechatronics approach*	*Structural modeling using SysML*	*Detailed modelling procedures and simulation parameters.*	*Detailed modelling procedures and simulation parameters.*
	SLO-2	*Need of design tools integration*	*Example*	*Structural modeling using SysML*	*Simulation methods*	*Simulation methods*
S-7	SLO-1	*Review of key elements of mechatronics systems from integration perspective*	*Real-time simulations (xPC)*	*Behavioral modeling using SysML*	*Key integration issues specific to the system under consideration*	*Key integration issues specific to the system under consideration*
	SLO-2	*Example*	*Example*	*Behavioral modeling using SysML*	*Key integration issues specific to the system under consideration*	*Key integration issues specific to the system under consideration*

Duration (hour)		Introduction to mechatronic system design	Mechatronics design concepts	Model based system engineering	Case Study-1	Case Study-2
		15	15	15	15	15
S-8	SLO-1	*Role of mechatronics engineer.*	*concurrent development of subsystems*	*Identifying complexities through different levels of abstractions and refinement*	*System integration*	*System integration*
	SLO-2	*Various steps for design*	*Example*	*Identifying complexities through different levels of abstractions and refinement*	*System integration*	*System integration*
S 9-10	SLO-1	*Lab 2*	*Lab 5*	*Lab 8*	*Lab 11*	*Lab 14*
	SLO-2					
S-11	SLO-1	*Types of design (mecahtronics approach)*	*Real-time Hardware-In-Loop simulation (HIL)*	*Adding constraints*	*Control techniques adopted*	*Control techniques adopted*
	SLO-2	*Example*	*Example*	*Interaction diagrams*	*Related Control theory*	*Related Control theory*
S-12	SLO-1	*integrated product design*	*Running the controller model and plant model on real-time target*	*Automatic approach for synergistic verification and validation*	*Selection of hardware components based on the model based design*	*Selection of hardware components based on the model based design*
	SLO-2	*load conditions on mechanisms*	*V&V using HIL RT model.*	*Automatic approach for synergistic verification and validation*	*Selection of hardware components based on the model based design*	*Selection of hardware components based on the model based design*
S-13	SLO-1	*Structure and systems*	*Rapid prototyping of mechatronic products-introduction to precision engineering*	*Performance analysis*	*System performance evaluation techniques*	*System performance evaluation techniques*
	SLO-2	*Man Machine Interface (MMI).*	*Example*	*Performance analysis*	*System performance evaluation techniques*	*System performance evaluation techniques*
S 14-15	SLO-1	*Lab 3*	*Lab 6*	*Lab 9*	*Lab 12*	*Lab 15: Model Practical Examination*
	SLO-2					

Note:

** List of plants/systems for case study 1,2 and 3 is listed below in the table. Faculty may choose any one plant/system from the list given and continue the same system/plant for the entire case study module

** List of experiments for the lab slots is listed below in the table for mechatronics as well as mechatronics with robotics specialization. Faculty in-charge may choose from the list of experiments to be provided for the various lab slots .

LIST OF PLANTS/SYSTEMS FOR CASE STUDIES		
CASE STUDY 1	CASE STUDY 2	CASE STUDY 3
Rotary Inverted pendulum	*Hybrid Electric Vehicle*	*Six Degree of freedom serial manipulator*
Inverted pendulum on a cart with rotary actuator	*Electronic Stability Control (ABS, EBD and ESP)*	*Six Degree of freedom parallel manipulator*
Inverted pendulum with Linear Actuator	*Active Suspension*	*Collision avoidance in mobile robotic systems*
Double inverted pendulum	*Engine Control System*	*Multi-rotor aerial vehicles*
Ball and Plate Control Systems	*Systems for Passenger Safety and Convenience*	*Haptics based teleoperation of manipulators*
Two wheeled Self Balancing Mobile Robot	*Cruise control*	*Cooperative manipulators*
Magnetically levitated Systems		*Underwater vehicles*

LIST OF EXPERIMENTS FOR LABORATORY EXERCISE FOR MECHATRONICS AND MECHATRONICS WITH ROBOTICS SPECILAIZATION	
MECHATRONICS	MECHATRONICS WITH ROBOTICS SPECILAIZATION
Quadrature decoding of incremental encoder	*Quadrature Encoder Decoding for Position and Velocity Estimation of a DC Servo Motor*
Closed loop position control of DC motor	*Mathematical modeling and control of physical system*
Open loop control of mobile robot	*Physical Modelling of a Differential Drive Robot*
Closed loop control of mobile robot with wheel encoders	*Closed Loop Control of a Differential Drive Robot with Wheel Encoder and Acoustic Ranging*
Mathematical modeling and control of physical system.	*Localization and Global Path Planning for a differential drive robot in a occupancy grid*
Introduction to physical modeling	*Closed loop control of pneumatics*
Creating requirements models of systems using SysML in different context and views	*Closed control of pneumatics with PLC*
MBSE approach for elevator	*Introduction to hardware in loop simulation*
Localization and Global Path Planning for a differential drive robot in a occupancy grid	*Introduction to forward and inverse Kinematics of a serial Manipulator*

LIST OF EXPERIMENTS FOR LABORATORY EXERCISE FOR MECHATRONICS AND MECHATRONICS WITH ROBOTICS SPECILAIZATION	
Introduction to hardware in loop simulation	*Introduction to velocity Kinematics of a Serial Manipulator*
One degree of freedom pitch control (VTOL).	*Trajectory Planning in Joint Space for Serial Manipulator*
Control of rotary inverted pendulum	*Trajectory Planning in Cartesian Space for Serial Manipulator*
Closed loop control of pneumatics	*Position Control of Serial Manipulator – Application task*
Closed control of pneumatics with PLC	*Force/Position Control of Serial Manipulator- Application task*

Learning Resources	1. Devdasshetty, Richard A.Kolk "Mechatronics Systems Design", Cengage Learning, 2011. 2. D A Bradley and et al,"Mechatronics-Electronics in Products and Processes",Springerscience+business media 3. Ni_mechatronics_machine_design_guide from ni.com. 4. Advanced model based systems design courseware from mathworks.com. 5. Quanser QNET Practical Control Guide (available in Mechatronics Laboratory).	6. Quanser QNET VTOL Laboratory manual (available in Mechatronics Laboratory). 7. Quanser QNET Rotary Inverted Pendulum manual (available in Mechatronics Laboratory). 8. Laboratory manual for Mechatronics Laboratory, SRMIST 9. Dennis M.Buede& William D.Miller., "The Engineering Design of Systems Models and Methods" 3rd Edition, Wiley, 2016

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Ganesh Ram, Intel Labs ,Bangalore, ganeshram.nandakumar.@intel.com	*1. Dr., R. Thiyagarajan, Visiting faculty, IIT Madras, thiyaguiitm@gmail.com*	*1. Mr.KSivanathan, SRMIST*
2. Mr. Mohammed Sagheer ,Wabco Technology Center ,India, mohammedsagheer.musthafa@wabco-auto.com	*2. Dr., P Karthikeyan, MIT,Anna University, pkarthikeyan@annauniv.edu*	*2. Mr.Ranjith Pillai R, SRMIST*

Course Code	18MHC350T	Course Name	COMPREHENSION	Course Category	C	Professional Core	L	T	P	C
							0	1	0	1

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechatronics Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	*Acquire skills to solve real world problems in Heat transfer, Mechanisms and its inversions*			
CLR-2 :	*Acquire skills to solve real world problems related to Vibrations, Mechanics of Solids and Fluids*			
CLR-3 :	*Acquire skills to solve real world problems in DC and AC machines and controllers for actuations*			
CLR-4 :	*Acquire skills to solve real world problems in Control systems and System Dynamics*			
CLR-5 :	*Acquire skills to solve real world problems related to Digital systems*			
CLR-6 :	*Acquire skills to solve real world problems in hydraulics, Pneumatic systems and Sensors*			

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Program Learning Outcomes (PLO)														
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
					Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design,	Modern Tool Usage	Society & Culture	Environment &	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Practice and gain confidence and competence to solve problems in Heat transfer, Mechanisms and its inversions*	*3*	*85*	*80*	*H*	*H*	*H*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*M*	*L*	*M*
CLO-2 :	*Practice and gain confidence and competence to solve problems related to Vibrations, Mechanics of Solids and Fluids*	*3*	*85*	*80*	*H*	*H*	*M*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*M*	*M*	*M*
CLO-3 :	*Practice and gain confidence and competence to solve problems in DC and AC machines and controllers for actuations*	*3*	*85*	*80*	*H*	*H*	*M*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*M*	*L*	*M*
CLO-4 :	*Practice and gain confidence and competence to solve problems Control systems and System Dynamics*	*3*	*85*	*80*	*H*	*H*	*M*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*M*	*M*	*M*
CLO-5 :	*Practice and gain confidence and competence to solve problems related to Digital systems*	*3*	*85*	*80*	*H*	*H*	*H*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*M*	*L*	*M*
CLO-6 :	*Practice and gain confidence and competence to solve problems in hydraulics, Pneumatic systems and Sensors*	*3*	*85*	*80*	*H*	*H*	*M*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*M*	*M*	*M*

Duration (hour)		3	3	3	3	3
S-1	SLO-1	*Review of Laws of Thermodynamics*	*Review of Vibrations*	*Review of DC and AC machines*	*Review of Time response and Frequency response of systems*	*Review of Interfacing concepts*
	SLO-2	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*
S-2	SLO-1	*Review of Modes of Heat Transfer*	*Tutorial on beams and columns*	*Review of Controllers for actuation*	*Review of Poles and Zeros*	*Tutorial on hydraulics and Pneumatics*
	SLO-2	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*
S-3	SLO-1	*Review of Links and Inversions of Mechanisms*	*Review of Fluid properties and Fluid through pipes*	*Discussion on Properties of Signals and Systems*	*Discussion on Design of Digital circuits*	*Review of types of sensors*
	SLO-2	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*

Learning Resources	1. *Bansal R K Strength of Materials,6th edition, Lakshmi publications. Pvt. Ltd, 2018d & Co., 2018* 2. *B L Thereja, A K Thereja, A Text book of Electrical Technology, Volume II, S. Chand Publications, 2008.*	3. *K Ogata, System Dynamics, 3rd edition, Prentice Hall, 1998.* 4. *M Moris Mano, Michael D Ciletti, Digital Design, 5th edition, Pearson, 2014*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)								Final Examination	
		CLA – 1 (20%)		CLA – 2 (30%)		CLA – 3 (30%)		CLA – 4 (20%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*40%*	-	*30%*	-	*30%*	-	*30%*	-	-	-
	Understand										
Level 2	Apply	*40%*	-	*40%*	-	*40%*	-	*40%*	-	-	-
	Analyze										
Level 3	Evaluate	*20%*	-	*30%*	-	*30%*	-	*30%*	-	-	-
	Create										
	Total	100 %		100 %		100 %		100 %		-	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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1. Dr. K.Karthikeyan, R&D specialist, ABB India Ltd, Bangalore, sayalkarthik@yahoo.co.in	*1. Dr.B.Mohan, Professor, Anna University, Chennai, mohan@mitindia.edu*	*1. Dr. G.Murali , SRMIST*
2. Dr. A. Velayutham, DRDO, Avadi, velayudham.a@cvrde.drdo.in	*2. Mr. Ramesh Ramanathan ,rramanathan@outlook.com*	*2. Mr. S. Muralidharan, SRMIST*