EKLAVYA UNIVERSITY
ज्ञान प्राप्तये लक्ष्य संधानम्
Estd. by Madhya Pradesh Niji Vishvavidyalaya (Sthapna Evam Sanchalana) Adhyadesh, 2020

SCHOOL OF ENGINEERING

SYLLABUS

CONTROL SYSTEM

Class		M.TECH	L	T	P	C
Semester/Year		I/I	3	-	-	3
Subject Name		Mathematical Methods in Control				
Subject Code		MEXCS20S101				
Paper	English					
	Hindi					
Max. Marks		100				

Course Objectives:-

1. To give the students an understanding of foundational concept in linear algebra and random processes for use in controlsystems.
2. To understand Probability, Randomvariables.

Course Outcomes:-

Students will be able to:-

CO1: Apply matrix properties and functions to a givenproblem.
CO2: Acquire knowledge about vector spaces, eigenvalues and eigen vectors of linear operators.
CO3: Acquire knowledge about random variables, probability distribution of random variables and transformation of random variables.
CO4: Identify correlationmatrices.
CO5: Find out responses of linear systems to any given inputsignal.

Unit	Syllabus	Periods
UNIT-I	Linear Spaces – Vectors andMatrices, Transformations,Norms Matrix Factorization.	8
UNIT-II	Eigenvalue, Eigenvectors andApplications, SVD andApplications, Projections and Least SquareSolutions.	9
UNIT-III	Probability, Randomvariables, Probability distribution and density functions, Joint density and conditional distribution, Functions of random variables and randomvectors.	11
UNIT-IV	Characteristic functions and correlationmatrices.	13
UNIT-V	Random Processes andproperties, Response of Linear systems to stochastic inputs, PSDtheorem.	14

	Text Books: **1.** Higher Engineering Mathematics by B.V. Ramana, Tata Mc Hill. **2.** Advance Engineering Mathematics by Ervin Kreszig, Wiley EastenEdd. Numerical Solution of Differential Equation by M. K.	
	Reference Books: **1.** G. Strang, "Introduction to Linear Algebra", 4 thEdition, Wellesley-Cambridge Press,2009. **2.** Papoulis & Pillai, "Probability, random variable and stochastic processes", Mcgraw Hill,2002. **3.** H. Stark & J.W. Woods, "Probability and random processes with application to signal processing", Pearson Education Asia, 2002. **4.** J A Gubner: "Probability and Random processes for Electrical and Computer engineers", Cambridge Univ. Press.2006.	

SYLLABUS

CONTROL SYSTEM

Class		M.TECH	L	T	P	C
Semester/Year		I/I	3	-	-	3
Subject Name		NONLINEAR CONTROL SYSTEMS				
Subject Code		MEXCS20S102				
Paper	English					
	Hindi					
Max. Marks		100				

Course Objectives:

1. Introduce fundamental concepts of nonlinear dynamicalsystems.

2. Understanding basic tools for mathematical analysis as well asapplications.

Course Outcomes:

Students will be able to:-

CO1: Acquire knowledge of linear system modeling, analysis and design so as to obtain the ability to apply the same to engineering problems in a global perspective.

CO2: Acquire knowledge on carrying out detailed stability analysis of non-linear systems with a view to extend this knowledge for controller design to achieve stability of system.

CO3: Acquire knowledge on Lyapunov stability and L stability.

CO4: Learn the perturbation method for solution of nonlinear system dynamics.

CO5: Understand the field of industrial automation.

Unit	Syllabus	Periods
UNIT-I	Introduction to nonlinear systems: Examples of phenomena, models & derivation of systemequations.	8
UNIT-II	Fundamental properties: Existence & uniqueness, Dependence on initial conditions &parameters.Phase planeanalysis.	9
UNIT-III	Limit cycles & oscillations, Describing function method andapplications, Circle criterion, Lyapunov stability of autonomoussystems.	11
UNIT-IV	Perturbation theory &Averaging, Singular perturbation model and stabilityanalysis.	13
UNIT-V	Basic results on Lie algebra. Controllability and Observability of nonlinear systems.Bifurcations. Chaos.Synchronization.	14

	Text Books: **1.** HJ.E. Gibson, Non Linear Automatic Control" Mc Graw Hill. **2.** H. K. Khalil, “Nonlinear systems”, 3rd edition, Prentice Hall,2001. **3.** M. Vidyasagar, “Nonlinear Systems Analysis, Society for Industrial and Applied Mathematics”, 2002.	
	Reference Books: **1.** B C Kuo, "Discrete Data Control Systems, Prentice Hall. **2.** Hahn Theory and Application of Liapunovs direct method Prentice IlaJI. **3.** J. J. E. Slotine and W. Li, “Applied nonlinear systems”, Prentice Hall,1991. **4.** A. Nijemjer and A. van der schaft, “Nonlinear dynamical control systems”, Springer,1989. **5.** S. Strogatz, “Nonlinear Dynamics and Chaos”, Westview Press,2001.	

SYLLABUS

CONTROL SYSTEM

Class		M.TECH	L	T	P	C
Semester/Year		I/I	3	-	-	3
Subject Name		ROBOTICS AND AUTOMATION				
Subject Code		MEXCS20S103				
Paper	English					
	Hindi					
Max. Marks		100				

Course Objectives:

1. To study the various parts of robots and fields ofrobotics.
2. To study the various kinematics and inverse kinematics ofrobots.
3. To study the trajectory planning forrobot.
4. To study the control of robots for some specificapplications.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1: Obtain forward, reverse kinematics and dynamics model of the industrial robot arm.
CO2: Propose and synthesize control law for a givenapplication.
CO3: Obtain kinematic model of a robot (DOF $\leq$3).
CO4: Design a linear / nonlinear controller for a robot.
CO5: Choose a sensor for a robot depending on the application.

Unit	Syllabus	Periods
UNIT-I	Basic concepts: definition and origin of robotics, different types ofrobotics various generations of robots, degrees of freedom, asimov's laws of robotics, dynamic stabilization ofrobots.	8
UNIT-II	Power Sources And Sensors : Hydraulic, pneumatic and electricdrives Determination of HP of motor and gearing: ratio, variable speedarrangements, Path determination, micro machines in robotics, Machine vision, ranging, laser, acoustic, magnetic, fiber optic and tactile sensors.	9
UNIT-III	Manipulators, Actuators And Grippers: Construction of manipulators, manipulator dynamics and forcecontrol, Electronic and pneumatic manipulator control circuits , endeffectors.	11
UNIT-IV	Kinematics And Path Planning: Solution of inverse kinematicsproblem Multiple solution Jacobian work envelop, hill climbing techniques, Robot programminglanguages.	13

UNIT-V	Manufacturing and non- manufacturing applications, robot cell design, selection ofrobot, Robot Control: Linear methods, Non-linearmethods.	**14**
	Text Books: **1.** Mikell P. Weiss G.M., Nagel R.N., Odraj N.G. "Industrial Robotics",McGraw-Hill Singapore,1996. **2.** Robert J Schilling, "Fundamentals of Robotics-Analysis and Control", Pearson Education, Asia.	
	Reference Books: **1.** R. K. Mittal and J. Nagrath, "Robotics and Control", Tata McGraw-Hill Education. **2.** Deb.S.R., "Robotics technology and flexible Automation", John Wiley, USA1992. **3.** Asfahl C.R., "Robots and manufacturing Automation", John Wiley, USA1992. **4.** Lorenzo Sciavicco& Bruno Siciliano, "Modeling and Control of Robot manipulator", The McGraw Hill Companies.	

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Class		**M.TECH**	**L**	**T**	**P**	**C**
Semester/Year		**I/I**	**3**	**-**	**-**	**3**
Subject Name		**DIGITAL CONTROL**				
Subject Code		**MEXCS20S104**				
Paper	**English**					
	Hindi					
Max. Marks		**100**				

Course Objectives:

1. To familiarize the student with the concept ofdiscretization.
2. Introduction to discrete-time system representations and digitalcontrol.Learn to design controller for digitalsystems.

Course Outcomes:

Upon completion of the course, the students will be able to:
CO1: Analyse a discrete-time system and evaluate its performance.
CO2: Design suitable digital controller for the system to meet the performance specifications.
CO3: Design a digital controller and observer for the system and evaluate its performance.
CO4: Acquire knowledge on control design based on differentialsampling.
CO5: Acquire knowledge on sampled datasystems, Control of Sampled datasystems.

Unit	Syllabus	Periods
UNIT-I	Introduction to discrete-timesystems.	**8**
UNIT-II	Frequency domain approach – Analysis anddiscretization, Time domain approach, analysis and discretization, State space formulation for discretizedsystems.	**9**
UNIT-III	Engineering aspects of computer controlledsystems**.**	**11**
UNIT-IV	Sampled datasystems, Control of Sampled datasystems**.**	**13**
UNIT-V	Concept of differential sampling, Closed loop analysis ofdifferentially sampled systems, Control design based on differentialsampling, Recent applications of DigitalControl.	**14**
	Text Books: **1.**K. Ogata, “Discrete-time Control Systems’, Ed. 2, Prentice-Hall,1995.	

	2. Benjamin C. Kuo, "Digital Control Systems", Ed. 2, Oxford Uiversity Press,1999.	
	Reference Books: **1.** Gene F. Franklin, J. David Powell, Michael Workman, Digital Control of Dynamic Systems, Pearson, Asia. **2.** K. Ogata, Discrete-Time Control Systems, Pearson Education, Asia. **3.** Frank L. Lewis,Applied Optimal Control& Estimation, Prentice-Hall, Englewood Cliffs NJ, 1992. **4.** Benjamin C. Kuo, Digital Control Systems, 2/e, Saunders College Publishing, Philadelphia, 1992.	

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CONTROL SYSTEM

Class		M.TECH	L	T	P	C
Semester/Year		I/I	3	-	-	3
Subject Name		NON-LINEAR CONTROL				
Subject Code		MEXCS20S105				
Paper	English					
	Hindi					
Max. Marks		100				

Course Objectives:-

1. To study concepts and techniques for stability analysis.
2. Learning control design of nonlinearsystems.

Course Outcomes:-

Students will be able to:-

CO1: Acquire knowledge of linear system modeling, analysis and design so as to obtain the ability to apply the same to engineering problems in a global perspective.

CO2: Acquire knowledge on carrying out detailed stability analysis of non-linear systems with aview to extend this knowledge for controller design to achieve stability of systems.

CO3: Acquire knowledge on Lyapunov stability and L stability.

CO4: Learn the perturbation method for solution of nonlinear system dynamics.

CO5: Understand the field of industrial automation.

Unit	Syllabus	Periods
UNIT-I	Overview of nonlinear Control-Introduction to Advanced Calculus, Elementary notions, ofTopology Smooth Manifolds, Sub-manifolds, Tangent Vectors, VectorFields.	**8**
UNIT-II	Lyapunov stability for autonomous and non-autonomoussystems, Input-Output Stability and Input- to-State Stability AbsoluteStability.	**9**
UNIT-III	Passivity analysis and applications to control design,Lyapunov-basedfeedback controldesign.Feedback linearization and backstepping**.**	**11**
UNIT-IV	Sussmann‘s Theorem and globalDecompositions, The Control Lie Algebra, the observationspace**.**	**13**
UNIT-V	Local Co-ordinates, Transformations, Exact Linearization ViaFeedback, The Zero dynamics, Local. AsymptoticStabilization, Asymptotic OutputTracking. Disturbance Decoupling, High GainFeedback, Additional Results on Exact Linearization, Observers with Linear Error Dynamics.	**14**

	Text Books: **1.** H. K. Khalil, “Nonlinear Systems”, 3rd edition, Prentice Hall,2001. **2.** J. J. E. Slotine and W. Li, “Applied nonlinear systems”, Prentice Hall,1991.	
	Reference Book(S):- **1.** A. Nijemjer and A. van der schaft, “Nonlinear dynamical control systems”, Springer,1989.. **2.** M. Vidyasagar, “Nonlinear Systems Analysis, Society for Industrial and AppliedMathematics”, 2002. **3.** Frank L. Lewis,Applied Optimal Control& Estimation, Prentice-Hall, Englewood Cliffs NJ, 1992. **4.** Benjamin C. Kuo, Digital Control Systems, 2/e, Saunders College Publishing, Philadelphia, 1992.	

SYLLABUS

CONTROL SYSTEM

Class		M.TECH	L	T	P	C
Semester/Year		I/I	3	-	-	3
Subject Name		SYSTEMS BIOLOGY				
Subject Code		MEXCS20S106				
Paper	English					
	Hindi					
Max. Marks		100				

Course Objectives:-

1. Introduction to Mathematical Model and FrameWork.
2. Learning of core –Process , Pulses andOscillations.

Course Outcomes:-

Students will be able to:-

CO1: Understand and apply mathematical models to design a particularsystem.
CO2: Apply feed-forward loops to design a biological controlsystem.
CO3: Acquire knowledge on Robustness toPerturbations.
CO4: Give the knowledge about Feed-forward Loops, Fold Change Detection.
CO5: Acquire knowledge on Pulses andOscillations,Circadian Rhythms and Clocks SpatialPatterns.

Unit	Syllabus	Periods
UNIT-I	Mathematical models and frameworks: Law of mass action, Master equationDeterministic vs stochastic, Spatialaspects.	8
UNIT-II	Examples of core processes: gene expression, proteindegradation, phosphorylation equilibrium solutions & their bifurcations switches & bi-stability.	9
UNIT-III	Pulses andOscillations,Circadian Rhythms and Clocks Spatialpatterns, Morphogenesis andDevelopment.	11
UNIT-IV	Robustness toPerturbations, Integral FeedbackControl,Homeostasis and PerfectAdaptation.	13
UNIT-V	Feed-forwardLoops,Fold ChangeDetection.	14
	Text Book(s):- **1.** N. G. van Kampen, “Stochastic Processes in Physics and Chemistry”,	

	North-Holland 3rd edition2007. **2.** U. Alon, "An Introduction to Systems Biology, Chapman & Hall/ CRC Mathematical and Computational Biology", 2006.	
	Reference Book(S):- **1.** J. D. Murray, "Mathematical Biology parts I & II", Springer 3rd edition, 2007. **2.** E. Klippet. al, "Systems Biology", Wiley-Blackwell,2009. **3.** S. Strogatz, "Nonlinear Dynamics and Chaos", Westview Press,2001. **4.** D. D. Vecchio& R. M. Murray, "Biomolecular Feedback Systems", Princeton University Press,2014.	

SYLLABUS

CONTROL SYSTEM

Class		M.TECH	L	T	P	C
Semester/Year		I/I	3	-	-	3
Subject Name		SCADA SYSTEM AND APPLICATIONS				
Subject Code		MEXCS20S107				
Paper	English					
	Hindi					
Max. Marks		100				

Course Objectives:-

1. To understand what is meant by SCADA and itsfunctions.
2. To know SCADAcommunication.
3. To get an insight into itsapplication.

Course Outcomes:-

Students will be able to:-

CO1: Acquire knowledge about SCADA architecture, various advantages and disadvantages of each system.

CO2: Describe the basic tasks of Supervisory Control Systems (SCADA) as well as their typical applications.

CO3: Knowledge about single unified standard architecture IEC61850.

CO4: Learn about SCADA system components: remote terminal units, PLCs, intelligent electronic devices, HMI systems, SCADAserver.

CO5: Learn and understand about SCADA applications in transmission and distribution sector, industries, etc.

Unit	Syllabus	Periods
UNIT-I	Introduction to SCADA: Data acquisitionsystems, Evolution ofSCADA, Communicationtechnologies.	8
UNIT-II	Monitoring and supervisory functions, SCADA applications in UtilityAutomation, IndustriesSCADA.	9
UNIT-III	Industries scada system components: schemes- remote terminal unit (rtu), intelligentelectronic devices(ied), programmable logic controller(plc),communicationnetwork,scada server, scada/hmisystems.	11

UNIT-IV	SCADA Architecture: Various SCADA architectures, advantages and disadvantages of each system - single unified standard architecture -IEC 61850.	**13**
UNIT-V	SCADA Communication: various industrial communication technologies - wired and wireless methods and fiberoptics open standard communicationprotocols. SCADA Applications: Utility applications-Transmission and Distribution sector-operations, monitoring, analysis andimprovement, Industries - oil, gas andwater.Case studies, Implementation, SimulationExercises.	**14**
	Text Book(s):- **1.** Stuart A. Boyer: "SCADA-Supervisory Control and Data Acquisition", Instrument Society of America **2.** Gordon Clarke, Deon Reynders: "Practical Modern SCADA Protocols: DNP3, 60870.5.	
	Reference Book(S):- **1.** William T. Shaw, "Cybersecurity for SCADA systems", PennWell Books,2006 **2.** David Bailey, Edwin Wright, "Practical SCADA for industry", Newnes,2003 **3.** Michael Wiebe, "A guide to utility automation: AMR, SCADA, and IT systems for electric power. **4.** D. D. Vecchio& R. M. Murray, "Biomolecular Feedback Systems", Princeton University Press,2014.	

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CONTROL SYSTEM

Class		M.TECH	L	T	P	C
Semester/Year		I/I	3	-	-	3
Subject Name		DESIGN ASPECTS IN CONTROL				
Subject Code		MEXCS20S108				
Paper	English					
	Hindi					
Max. Marks		100				

Course Objectives:

1. The student is introduced to the tools and techniques of control systemdesign.

2. Introduction to various aspects of controller designphilosophy.

3. Learning PIDController.

Course Outcomes:

Students will be able to:-

CO1: Acquire knowledge about SystemModelling.

CO2: Acquire knowledge about FOPDT and SOPDT systems.

CO3: Knowledge about PID Controllers – review PID Tuning – Ziegler Nichols.

CO4: Learn about Eigen structure assignment, Eigen structure..

CO5: Learn and understand about Unstable zero dynamics – controldesign.

Unit	Syllabus	Periods
UNIT-I	SystemModelling, review ofconcepts.	8
UNIT-II	FOPDT and SOPDT systems and identification Smith Predictor andits Variations.	9
UNIT-III	PID Controllers – review PID Tuning – Ziegler Nichols,Cohen-Coon, techniques.	11
UNIT-IV	State feedback review – pole placement, Eigen structure assignment, Eigen structure – time responserelation, Controller gain selection, controller robustness, disturbancerejection.	13
UNIT-V	Frequency Domain LoopShapingLag, Lead and Lag-leadcompensators,Zero dynamics in servo control, Unstable zero dynamics – controldesign, Observer – concept and design, Case studies –Applications.	14
	Text Books:	

	1. Karl J. Astrom, Richard M. Murray, "Feedback Sytems : An Introduction for Scientists and Engineers", Princeton University Press,2010. **2.** Thomas Kailath : "Linear Systems",Prentice-Hall.	
	Reference Books: **1.** Gene F. Franklin, J. David Powell, Michael Workman, Digital Control of Dynamic Systems, Pearson, Asia. **2.** K. Ogata, Discrete-Time Control Systems, Pearson Education, Asia.	

SYLLABUS

CONTROL SYSTEM

Class		M.TECH	L	T	P	C
Semester/Year		I/I	-	-	4	2
Subject Name		CONTROL LAB -1				
Subject Code		MEXCS20S109				
Paper	English					
	Hindi					
Max. Marks		50				

CONTROL LAB -1

List of Experiments:

1. Design and simulation of Linearised models using MATLAB/PSPICE.
2. Simulation and analysis of State space models for continuous time and discrete time systems using MATLAB/PSPICE.
3. Design and Simulation of LTI models of Feedback Control System using MATLAB/PSPICE.
4. Simulation and analysis of Digital Control System using MATLAB/PSPICE.
5. Simulation and Stability analysis of control system with common non-linearities using MATLAB/PSPICE.
6. Familiarization and use of MATLAB command associated with Robust Control Systems.
7. Familiarization and use of PSIM software.

SYLLABUS

CONTROL SYSTEM

Class		M.TECH	L	T	P	C
Semester/Year		I/I	-	-	4	2
Subject Name		CONTROL LAB -2				
Subject Code		MEXCS20S110				
Paper	English					
	Hindi					
Max. Marks		50				

CONTROL LAB -2

List of Experiments:

1. Designing of Ladder logic for various practical applications.
2. Execution of the Ladders using PLC's.
3. Study of Analog and Digital Servo Systems.
4. Experiment on Position Control System.
5. Experiment on Velocity Control System.
6. Experiment on Adaptive Control System.
7. Experiment on Non-Linear Control Systems.

SYLLABUS

CONTROL SYSTEM

Class		M.TECH	L	T	P	C
Semester/Year		I/I	2	-	-	2
Subject Name		Research Methodology and IPR				
Subject Code		MEXCS20S111				
Paper	English					
	Hindi					
Max. Marks		100				

Course Objectives:

1. To explain various research designs and their characteristics.
2. To explain several parametric tests of hypotheses and Chi-square test.
3. To explain the art of interpretation and the art of writing research reports.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1: Understand research problemformulation.

CO2: Analyze research relatedinformation, applications, Follow researchethics.

CO3: Understand that today's world is controlled by Computer, Information Technology but tomorrow world will be ruled by ideas, concept, andcreativity.

CO4: Understand Nature of Intellectual Property.

CO5. Understand that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering inparticular.

Unit	Syllabus	Periods
UNIT-I	Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem. Scope and objectives of research problem, Approaches of investigation of solutions for research problem, data collection,analysis, interpretation.	8
UNIT-II	Effective literature studies approaches, analysis lagiarism, Research ethics.	9
UNIT-III	Effective technical writing, how to write report, Pape developing a Research Proposal, Format ofresearch proposal, a presentation and assessment by a review committee.	11
UNIT-IV	Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	13

UNIT-V	Frequency Domain Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs .	**14**
	Text Books: **1.** Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineeringstudents'" **2.** Wayne Goddard and Stuart Melville, "Research Methodology: AnIntroduction".	
	Reference Books: **1.** Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age",2016. **2.** Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd,2007. **3.** T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand,2008. **4.** RanjitKumar, 2nd Edition , "Research Methodology: A Step by Step Guide forbeginners"	

SYLLABUS

CONTROL SYSTEM

Class		M.TECH	L	T	P	C
Semester/Year		I/I	2	-	-	-
Subject Name		English for Research Paper Writing				
Subject Code		MEXCS20S112				
Paper	English					
	Hindi					
Max. Marks		-				

Course Objectives:

1. The aim of the course is to improve competence in scholarly communications by deepening knowledge of the core features of the scientific writing style.
2. In particular, they will develop an awareness of fundamental concepts of academic writing, suchas contrastive rhetoric, logical organization, and argumentation.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1: Understand Planning and Preparation.
CO2: Understand about Paraphrasing and Plagiarism, Sections of a Paper.
CO3: Understand that which type of key skills needed when writing different type of headings.
CO4: Understand the skills needed when writing a Title Ensure the good quality of paper at veryfirst-time submission.
CO5: Learn about what to write in each section.

Unit	Syllabus	Periods
UNIT-I	Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs andSentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.	8
UNIT-II	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction, Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	9
UNIT-III	Key skills needed when writing a Title, key skills needed when writing an Abstract, key skillsNeeded when writing an Introduction, skills needed when writing a Review of the Literature.	11
UNIT-IV	Skills needed when writing the Methods, skills needed when writing the Results, skills needed when writing the Discussion, skills are needed when writing the Conclusions.	13

UNIT-V	Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.	**14**
	Text Books: **1.** Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press. **2.** Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook	
	Reference Books: **1.** Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books). **2.** Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London,2011.	

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Class		M.TECH	L	T	P	C
Semester/Year		II/I	3	-	-	3
Subject Name		OPTIMAL CONTROL THEORY				
Subject Code		MEXCS20S201				
Paper	English					
	Hindi					
Max. Marks		100				

Course Objectives:

1. Introduce the basic and fundamental concepts of optimal control theory, controllerdesign.
2. Introduction to computational aspects of optimalcontrol.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1. Combine the mathematical methods used in optimalcontrol to derive the solution to variations of the problemsstudied in thecourse.

CO2. Use the standard algorithms for numerical solution of optimal control problems and use Matlab to solve fairly simple but realisticproblems.

CO3. Integrate the tools learnt during the course and apply themto more complexproblems.

CO4. Understand the principle of optimality, Dynamic programming applied to routingproblems.

CO5. Learn about numerical techniques to determine optimaltrajectories.

	Syllabus	Periods
UNIT-I	Review of MatrixComputations. Introduction, Overview of SS Approach and Matrix Theory,Review of Numerical Methods.	**8**
UNIT-II	Maximization of functional ofa single and several functions using calculus of variations,Constrained externals,Euler-Lagrange Equation,Necessary conditions for optimalcontrol,Pontryagin's minimum principle and state inequalityconstraints,Minimum time problems,Minimum control effortproblems.	**9**
UNIT-III	Linear quadratic regulatorproblems,RiccatiEquation,Singular intervals in optimal controlproblems.	**11**
UNIT-IV	The principle of optimality, Application of the principle of optimality to decisionmaking,Dynamic programming applied to routingproblems.	**13**

UNIT-V	Solving optimal control problems using dynamicprogramming,Discrete linear regulatorproblem,Hamilton -Jacobi -BellmanEquation. Numerical Techniques to determine optimaltrajectories,Numerical Aspects ofOptimization.	**14**
	Text Books: **1.** M. Athans and P. L. Falb, “Optimal Control: An Introduction to the Theory and Its Applications”, Dover Books on Engineering,2006. **2.** D. S. Naidu, “Optimal Control Systems”, CRC Press,2002.	
	Reference Books: **1.** D. Liberzon, "Calculus Of Variations and Optimal Control Theory: A Concise Introduction", Princeton University Press, Dec2011. **2.** Frank L. Lewis, DragunaVrabie, Vassilis L. Syrmos, Optimal Control, 3rd Edition, Wiley,2012.	

SYLLABUS

CONTROL SYSTEM

Class		M.TECH	L	T	P	C
Semester/Year		II/I	3	-	-	3
Subject Name		STOCHASTIC FILTERING AND IDENTIFICATION				
Subject Code		MEXCS20S202				
Paper	English					
	Hindi					
Max. Marks		100				

Course Objectives:

1. To introduce fundamental concepts of stochastic filtering, prediction,control.
2. To introduce non-linear systemidentification.

Course Outcomes:

Students will be able to:-

CO1. Develop skills in analyzing and interpreting theresults.
CO2. Master essential stochastic modeling tools including Markovchains and queuingtheory.
CO3. Formulate and solve problems which involve setting up stochasticmodels.
CO4. Learn aboutRecursive Identification of linear dynamical system.
CO5. Learn about LQG and adaptivecontrol.

Unit	Syllabus	Periods
UNIT-I	Introduction to Parameter Estimation and SystemIdentification, MMSE estimation includingLMS, Gaussiancase.	**8**
UNIT-II	Wiener filtering &prediction,Kalman filtering & prediction,Extended Kalman filtering and itsvariations,Predictors fordifference equation based models including ARMA, Box Jenkins &others.	**9**
UNIT-III	Statistical properties of Least Squares estimation and itsrelationship with Bayes estimation (ML, MAP), convergenceanalysis, CRbound. Recursive Least Squares, Iterativemethods for nonlinear Least Squares Identification problem:Different approaches for linear dynamicalsystem,Offlineidentification methods including LeastSquares,Predictionerror framework,Pseudo-linear regression (PLR) &Instrument variablemethods.	**11**
UNIT-IV	Recursive Identification of linear dynamical system: RLS,PLR,Prediction error framework & its application to ARMA & Innovationsrepresentation,Convergence Analysis of Recursive	**13**

	Identificationmethods: Associated ODE, Martingale.	
UNIT-V	Nonlinear systemidentification, Subspace based method of systemidentification. Applications including LQG and adaptivecontrol.	**14**
	Text Books: **1.** Papoulis & Pillai, "Probability, random variable and stochastic processes", McGraw Hill,2002. **2.** T. Soderstrom and P. Stoica: "System Identification", Prentice-Hall,1989. **3.** LennartLjung: "System Identification, Prentice-Hall", 2nd edition,1999.	
	Reference Books: **1.** S. Thomas Alexander: "Adaptive Signal processing, Theory and applications", Springer-Verlag, 1986. **2.** R. Isermann and M. Munchhof: "Identification of Dynamic Systems", Springer-Verlag,2011 **3.** B. D. O. Anderson and J. B. Moore: "Optimal Filtering, Dover Books on Electrical Engineering", 2005.	

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SCHOOL OF ENGINEERING

SYLLABUS

CONTROL SYSTEM

Class		M.TECH	L	T	P	C
Semester/Year		II/I	3	-	-	3
Subject Name		ADVANCE CONTROL SYSTEM				
Subject Code		MEXCS20S203				
Paper	English					
	Hindi					
Max. Marks		100				

Course Objectives:

1. The course provides glimpses into the advanced methods of modeling and analysis ofthe dynamicalsystems.
2. The course is a strong step in inculcating the research aptitude in thestudents.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1: Understand about Math Modelling of Dynamical Systems.
CO2: Apply the concepts of linear algebra and their applications to controlsystem.
CO3: Apply the Concept and computation of systemsmodes.
CO4: Analyze the system dynamics and Lyapunov stabilitytheory.
CO5: Design linear quadraticcontroller.

Unit	Syllabus	Periods
UNIT-I	Math Modelling of Dynamical Systems: Newtonian and Lagrangian approaches,Concept of dynamical state of a system, Concept of equilibrium point, linearization of non-linearmodel.	8
UNIT-II	Review of Linear Algebra concepts: Field, Vector space,linear combination, linear independence, bases of a vectorspace, representation of any vector on different basis, matrix representation of a linear operator, change of basis, rank, nullity, range space and null space ofamatrix,Eigen value and Eigen vector of a matrix, similarity transform, diagonalisation.	9
UNIT-III	Modern Control Analysis: Concept and computation of systemsmodes,controllability theorem and itsproof,Observability theorem and itsproof,Controllable and observablesubspaces.	11
UNIT-IV	Stability Analysis: Stability of linear systems, stabilitytypes and their definitions for any generalsystem,Stability of an equilibrium point,	13

	Lyapunov stability theory for LTIsystems,Quadratic forms and Lyapunovfunctions.	
UNIT-V	Modern Control Design: Converting the math model to controllable canonical form and its use for poleplacement,Concept of linear observer and itsdesign,Design of reduced orderobserver,Compensator design using separationprinciple,Poles ofcompensator,Open loop and close-loopsystems, Optimal Control Theory: Introduction to the philosophy of optimal control, formulation of optimal control problem, different performancecriterion,Linear quadratic regulator (LQR) and optimum gainmatrix, Riccati equations, conceptual models and statistical models for random processes, Kalmanfilter.	**14**
	Text Books: **1.** "Modern Control Engineering" by K Ogata. **2.** "Advanced Control Systems Design" by Bernard Friedl. **3.** "Advanced Control Systems" by B N Sarkar. **4.** " Modern Control Engineering" by Roy Choudhury.	
	Reference Books: **1.** Bernard Friedland, "Control System Design: An Introduction to State-Space Methods", Dover Publications, Inc. Mineola, New York,2012. **2.** Thomas Kailath, "Linear Systems", Prentice-Hall Inc., New Jersey,1986. **3.** M. Gopal, "Modern Control System Theory", , New Age International (P) Limited, New Delhi, 2000.	

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SYLLABUS

CONTROL SYSTEM

Class		M.TECH	L	T	P	C
Semester/Year		II/I	3	-	-	3
Subject Name		ADVANCED ROBOTICS				
Subject Code		MEXCS20S204				
Paper	English					
	Hindi					
Max. Marks		100				

Course Objectives:

1. This course gives an in-depth view into the mathematical methods for modeling and control of roboticmanipulator.
2. Introduction to MobileRobots.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1: Understand about Math Modelling of Dynamical Systems.
CO2: Design a robotic control.
CO3: Apply non-linear techniques to any controlproblem.
CO4: Analyze the Vision based RoboticControl.
CO5: Model mobile robot.

Unit	Syllabus	Periods
UNIT-I	Review ofTransformations,DH Convention and KinematicsVelocity kinematics andJacobian.	8
UNIT-II	RobotDynamics,MotionPlanning.	9
UNIT-III	Robot control – Linear ControlTechniques,Nonlinear ControlTechniques.	11
UNIT-IV	Holonomic and Non-holonomicSystems,Vision based RoboticControl.	13
UNIT-V	Mobile Robots – Modeling, Odometry Analysis, Navigation with Obstacle Avoidance, Motion Capturing Systems.	14

	Text Books: **1.** John J. Craig, “Introduction to Robotics: Mechanics & Control”, 3rd Edition, Prentice Hall,2004. **2.** Introduction to AI Robotics, second edition, Robin R. Murphy,2019.	
	Reference Books: **1.** Mark W. Spong, Seth Huchinson and M. Vidyasagar, "Robot Modeling and Control", John Wiley and Sons, Inc.,2005. **2.** Discover The Robotic Innovations Of The Future - An Introductory Guide to RoboticsDr. Kevin Klein, 2016. **3.** Richard Murray, A. Lee, S. Sastry, “A Mathematical Introduction to Robotic Manipulation”, CRC Press,1994.	

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SYLLABUS

CONTROL SYSTEM

Class		M.TECH	L	T	P	C
Semester/Year		II/I	3	-	-	3
Subject Name		ADAPTIVE LEARNING AND CONTROL				
Subject Code		MEXCS20S205				
Paper	English					
	Hindi					
Max. Marks		100				

Course Objectives:

1. To introduce adaptive and learning techniques for control design for uncertain dynamical systems.
2. Introduction to learning based control.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1: Understand detailed knowledge of classical system identification and the development and properties of various methods.

CO2: Understand the use of Lyapunov stability theory design a roboticcontrol.

CO3: Understand detailed knowledge of on-line parameterestimation.

CO4: Understand knowledge of adaptive control systems and their development andproperties.

CO5: Understand knowledge of methods and tools for stability analysis of adaptivesystems.

Unit	Syllabus	Periods
UNIT-I	Introduction to adaptivecontrol,Direct and indirect adaptivecontrol,Model reference adaptivecontrol, Parameter convergence, Persistence ofexcitation	8
UNIT-II	Review of Lyapunov stabilitytheory.	9
UNIT-III	Adaptive backstepping,Adaptive control of nonlinearsystems,Composite adaptation,Robust adaptivecontrol.	11
UNIT-IV	Neural Network-basedcontrol, Reinforcement learning-basedcontrol.	13
UNIT-V	Repetitive learningcontrol, Predictive control, Robust adaptivecontrol	14

	Text Books: **1.** H. K. Khalil, “Nonlinear Systems”, 3rd edition, Prentice Hall,2002. **3.** S. Sastry and M. Bodson, “Adaptive Control”, Prentice-Hall,1989.	
	Reference Books: **1.** K. S. Narendra and A. M. Annaswamy, “Stable Adaptive Systems”, Prentice-Hall,1989. **2.** J.J.E. Slotine, and W. Li, “Applied Nonlinear Control”, Prentice-Hall, 1991. **3.** P. Ioannou& B. Fidan, “Adaptive Control Tutorial”, SIAM, Philadelpia, PA, 2006.	

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SYLLABUS

CONTROL SYSTEM

Class		M.TECH	L	T	P	C
Semester/Year		II/I	3	-	-	3
Subject Name		MODEL REDUCTION IN CONTROL				
Subject Code		MEXCS20S206				
Paper	English					
	Hindi					
Max. Marks		100				

Course Objectives:

1. Introduce the concept of model reduction of large scale dynamics models which from various engineeringdisciplines.
2. Introduction to model reduction incontrol.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1: Apply model reduction techniques for a given control designproblem.
CO2: Design control loops for all techniques..
CO3: Understand detailed knowledge of RouthApproximants.
CO4: Know modern methods.
CO5: Understand knowledge of SMC as model reducingcontrol.

Unit	Syllabus	Periods
UNIT -I	Introduction to ModelReduction,Source of Large Models – Circuits, EMsystems,MechanicalSystems.	8
UNIT -II	Classical Model Reduction Methods, Model Reduction inControl.	9
UNIT -III	Pade approximation and momentmatching,RouthApproximants.	11
UNIT -IV	Modern Methods - SVD (Grammian) based methods ,Krylov based methods,SVD-Krylov based methods,MOR for Nonlinear Systems – SVD & PODMethods.	13
UNIT -V	Sliding Mode Control –Review,SMC as model reducingcontrol, Higher Order SlidingMode.	14

	Text Books: **1.** A. C. Antoulas, “Approximation of Large Scale Dynamical Systems”, SIAM,2005. **2.** Ed. AlfioQuarteroni&GianluigiRozza, “Reduced Order Methods for Modeling and Computational Reduction”, Springer,2014. **3.** M. Jamshidi, “Large-scale systems: modelling & control”, North Holland, New York,1983.	
	Reference Books: **1.** C. Edwards and S. Spurgeon, “Sliding Mode Control : Theory and Applications”, CRCPress,1998. **2.** B.Bandyopadhyay,S.JanardhananandS.Spurgeon,“AdvancesinSlidingMode”,Springer,2013.	

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SYLLABUS

CONTROL SYSTEM

Class		M.TECH	L	T	P	C
Semester/Year		II/I	3	-	-	3
Subject Name		ROBUST CONTROL				
Subject Code		MEXCS20S207				
Paper	English					
	Hindi					
Max. Marks		100				

Course Objectives:

1. Introduction to control techniques with greater emphasis on robustness to modelinguncertainty.
2. Introduction to parameter variations, and presence of disturbances andnoise.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1: Understand LTI systems and itsapplications.
CO2: Apply Lyapunov theorem for any stabilityproblem.
CO3: Design passive systems in frequency and timedomain.
CO4: Analyze the Stabilizing controllers.
CO5: Apply mathematics in robotic design.

Unit	Syllabus	Periods
UNIT-I	Modeling of uncertainsystems, Signals andNorms.	**8**
UNIT-II	Lyapunov theory for LTIsystems.	**9**
UNIT-III	Passive systems – frequencydomain, Passive systems – timedomain.	**11**
UNIT-IV	Robust Stability and performance,Stabilizing controllers – Coprimefactorization.	**13**
UNIT-V	LQR, LQG problems, Ricatti equations and solutions, Ricatti equation solution throughLMI. H-infinity control andmu-synthesis,Linear matrix inequalities for robustcontrol.	**14**
	Text Books: **1.** L. Fortuna, M. Frasca (Eds.), "Optimal and Robust Control", CRC	

	Press, 2012. **2.** "Linear Optimal Control Systems" by Kwakernak and Sivan.	
	Reference Books: **1.** K. Zhou, J. C. Doyle and K. Glover, "Robust and Optimal Control", Prentice Hall, 1996. **2.** J. C. Doyle, B. A. Francis and A. R. Tannenbaum, "Feedback Control Theory", Macmillan, 1992.	

SYLLABUS

CONTROL SYSTEM

Class		M.TECH	L	T	P	C
Semester/Year		II/I	3	-	-	3
Subject Name		NETWORKED AND MULTI-AGENT CONTROL SYSTEMS				
Subject Code		MEXCS20S208				
Paper	English					
	Hindi					
Max. Marks		100				

Course Objectives:

1. To analyze and design control systems for networked and multi-agentsystems
2. Understand network optimizationtechniques.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1: Understand multi-agent controlsystems.
CO2: Know network optimization techniques and itsapplications.
CO3: Know about leader-followerarchitecture.
CO4: Analyze the Control under CommunicationConstraints.
CO5: Design multi-robot or vehicle coordinationsystems.

Unit	Syllabus	Periods
UNIT-I	Overview of networkedsystems,Graph TheoryFundamentals.	8
UNIT-II	Graph-based NetworkModels,NetworkOptimization.	9
UNIT-III	Consensus Problem: cooperative control, leader-followerarchitecture.	11
UNIT-IV	Control under CommunicationConstraints, Formation Control, Swarming andFlocking,CollisionAvoidance.	13
UNIT-V	Game Theoretic Control of Multi-AgentSystems, Applications: Multi-robot/vehicle coordination, SensorNetworks,Social Networks, Smart Grids, BiologicalNetworks.	14

	Text Books: **1.** C. Godsil and G. Royle, "Algebraic Graph Theory", Springer, 2001. **2.** M. Mesbahi and M. Egerstedt , "Graph Theoretic Methods in Multi-Agent Networks", Princeton University Press, 2010.	
	Reference Books: **1.** Wei Ren, Randal W. Beard, "Distributed Consensus in Multi-vehicle Cooperative Control, Communications and Control Engineering Series", Springer-Verlag, London, 2008. **2.** F. Bullo, J. Cortes, and S. Martinez, "Distributed Control of Robotic Networks", Princeton 2009.	

SYLLABUS

CONTROL SYSTEM

Class		M.TECH	L	T	P	C
Semester/Year		II/I	3	-	-	3
Subject Name		ADVANCED DIGITAL SIGNAL PROCESSING				
Subject Code		MEXCS20S209				
Paper	English					
	Hindi					
Max. Marks		100				

Course Objectives:

1. To understand the difference between discrete-time and continuous-timesignals.
2. To understand and apply Discrete Fourier Transforms(DFT).

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1: Gain knowledge about the time domain and frequency domain representations as wellanalysis of discretetime, signals and systems.

CO2: Study the design techniques for IIR and FIR filters and their realizationstructures.

CO3: Acquire knowledge about the finite word length effects in implementation of digitalfilters.

CO4: Acquire knowledge about the various linear signal models and estimation of power spectrum of stationary randomsignals.

CO5: Design of optimum FIR and IIRfilters.

Unit	Syllabus	Periods
UNIT-I	Discrete time signals- Linear shift invariant systems- Stability and causality- Sampling of Continuous timesignalsDiscrete time Fourier transform- Discrete Fourier series- Discrete Fouriertransform- Z transform- Properties of differenttransforms.	8
UNIT-II	Linear convolution using DFT- Computation of DFT Design of IIR digital filters from analogfilterImpulse invariance method and Bilinear transformationmethod.	9
UNIT-III	FIR filter design using window functions- Comparison of IIR and FIR digital filters- Basic IIR and FIR filter realization structures- Signal flow graph representations Quantization process andErrorCoefficient quantization effects in IIR and FIRfilters.	11

UNIT-IV	A/D conversion noise- Arithmetic round-off errors- Dynamic range scaling- Overflow oscillations and zero Input limit cycles in IIRfilters, Linear SignalModels.	**13**
UNIT-V	All pole, All zero and Pole-zeromodels, Power spectrum estimation- Spectral analysis of deterministicsignals, Estimation of power spectrum of stationary randomsignals, Optimum linear filters- Optimum estimation- Optimum FIR and IIRFilters, signal estimation- Mean square error.	**14**
	Text Books: **1.** " Digital Signal Processing" by Proakis and Manolokis. **2.** " Theory and Application of Digital Signal Processing" by Rabinar L R and Gold B.	
	Reference Books: **1.** Dimitris G .Manolakis, Vinay K. Ingle and Stephen M. Kogon, "Statistical and Adaptive Signal Processing", Mc Grow Hill international editions .-2000. **2.** SanjitK Mitra, "Digital Signal Processing: A computer-based approach ",TataMc Grow-Hill Edition1998.	

SYLLABUS

CONTROL SYSTEM

Class		M.TECH	L	T	P	C
Semester/Year		II/I	-	-	4	2
Subject Name		ADVANCE CONTROL LAB1				
Subject Code		MEXCS20S210				
Paper	English					
	Hindi					
Max. Marks		50				

ADVANCE CONTROL LAB1

List of Experiments:

1. State space modeling of discrete time systems and study of responses.
2. Pole placement design for regulator and tracking discrete time systems.
3. Observer design for discrete time systems.
4. Design of digital kalman filter.
5. Optimal control design of digital systems.
6. Analysis of non linear systems using describing function method.
7. Phase plane analysis of non linear systems.

SYLLABUS

CONTROL SYSTEM

Class		M.TECH	L	T	P	C
Semester/Year		II/I	-	-	4	2
Subject Name		ADVANCE CONTROL LAB2				
Subject Code		MEXCS20S211				
Paper	English					
	Hindi					
Max. Marks		50				

ADVANCE CONTROL LAB2

List of Experiments:

1. Characteristics of Synchros: (a) Synchro transmitter characteristics.(b) Implementation of error detector using synchro pair.
2. Determination of Magnetic Amplifier Characteristics with different possible connections.
3. To determine the time response of closed loop second order process with P Control, PI Control and PID control and to determine the effect of disturbance on a process..
4. To study the compensation of the second order process by using: (a) Lead Compensator. (b) Lag Compensator. (c) Lead- Lag Compensator
5. To determination of AC servomotor Characteristics.
6. To study the position control of DC servomotor with P, PI control actions.

SYLLABUS

CONTROL SYSTEM

Class		M.TECH.	L	T	P	C
Semester/Year		II/I	-	-	4	2
Subject Name		Mini Project				
Subject Code		MEXCS20S212				
Paper	English					
	Hindi					
Max. Marks:		50				

Course objective:

1. The students will be able to understand and apply the knowledge of management functions like planning, scheduling, executing and controlling to projects.

2. The students will be able to implement the safety aspects during the execution project.

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Identify structural engineering problems reviewing available literature.

CO2: Study different techniques used to analyze complex structural systems.

CO3: Work on the solutions given and present solution by using his/her technique applying engineering principles.

Unit	Syllabus	Periods
	Mini Project will have mid semester presentation and end semester presentation. Mid semester presentation will include identification of the problem based on the literature review on the topic referring to latest literature available. End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research, collection and analysis of data, determining solutions highlighting individuals' contribution. Continuous assessment of Mini Project at Mid-Sem and End-Sem will be monitored by the departmental committee.	

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SYLLABUS

CONTROL SYSTEM

Class		M.TECH.	L	T	P	C
Semester/Year		II/I	2	-	-	-
Subject Name		Stress Management by Yoga				
Subject Code		MEXCS20S213				
Paper	English					
	Hindi					
Max. Marks:		-				

Course Objective:
After completing this module, you should be able to:
1. To achieve overall health of body and mind.
2. To overcome stress.

Course Outcomes:
After completion of course, students would be able to:
CO1: Develop healthy mind in a healthy body thus improving social health.
CO2: Improve efficiency.

Unit	Syllabus	Periods
UNIT-I	Definitions of Eight parts of yog. (Ashtanga)	**8**
UNIT-II	Yam and Niyam. Do`s and Don'tsin life. i) Ahinsa, satya, astheya, bramhacharyaandaparigraha. ii) Shaucha, santosh, tapa, swadhyay,ishwarpranidhan.	**9**
UNIT-III	AsanandPranayam i) Various yog poses and their benefits for mind &body **ii)**Regularization of breathing techniques and its effects-Types of pranayama.	**11**
	Reference Books: 1. Yogic Asanas forGroup Tarining-Part-I":Janardan SwamiYogabhyasiMandal,Nagpur. 2. Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama (Publication Department),Kolkata.	