DEPARTMENT OF MECHANICAL ENGINEERING

ANNA UNIVERSITY, CHENNAI

VISION OF THE DEPARTMENT

We, at the Department of Mechanical Engineering, Anna University shall strive hard to impart knowledge and state-of-the-art training to our students and expose them to broad areas of Mechanical Engineering, namely Design, Manufacturing, Energy, Thermal Sciences and currently related interdisciplinary areas, so that they can later practice their profession at home or abroad keeping in mind the needs and concern of the society they represent, safeguarding values, ethics and be instrumental in bringing about an overall technological development.

MISSION OF THE DEPARTMENT

1. To deliver knowledge in Mechanical Engineering with high educational standards so that the outgoing students are employable and globally competitive.
2. To produce graduate and post graduate engineers with core competency as well as relevant software skills and social responsibility.
3. To be dynamic in imparting knowledge to students depending upon the changing national and International needs.

ANNA UNIVERSITY, CHENNAI
NON- AUTONOMOUS COLLEGES AFFILIATED ANNA UNIVERSITY
M.E. INTERNAL COMBUSTION ENGINEERING (R 2021)
REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA & SYLLABI

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

The Internal Combustion Engineering program seeks to prepare PG students for productive and rewarding careers in the transport and mobility arena. The PEOs are listed below

I.	To develop skill and acquire knowledge in modern engine technologies and develop smart future mobility solutions
II.	To provide students with a solid foundation in mathematical, scientific and engineering fundamentals required to solve real time problems in engines and mobility science
III.	Become a successful entrepreneur and be a part of a supply chain or manufacture engine / mobility solutions for sustainable development.

2. PROGRAMME OUTCOMES (POs):

On successful completion of the Programme, graduates will possess:

PO#	Programme Outcomes
1	An ability to independently carry out research/investigation and development work to solve practical problems
2	An ability to write and present a substantial technical report/document
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
4	Demonstrate skills to use modern engineering tools, software and equipment's to analyze multidisciplinary problems.
5	An ability to develop a mobility solution, component, product and process for sustainable development.
6	Understand the impact of engineering solutions on societal transformation.

4. PEO/PO Mapping:

PEO	PO					
	1	**2**	**3**	**4**	**5**	**6**
I.	✓	✓	✓	-	✓	✓
II.	✓	✓	✓	-	-	-
III.	✓	✓	✓	✓	✓	✓

PROGRAM ARTICULATION MATRIX OF INTERNAL COMBUSTION ENGINEERING

		COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6
YEAR I	SEMESTER I	Advanced Numerical Methods	2	2.3	2.6	2	-	-
		Alternate Fuels for IC Engines	1.8	2.5	2.2	-	1.6	2
		Combustion in Engines	2.4	2.6	3	-	1.8	2
		Advanced Heat Transfer	2	1.6	2.6	-	-	-
		Advanced Thermodynamics	2	1	3	-	-	-
		Research Methodology and IPR	2.6	2.6	2.4	3	3	2.2
		Professional Elective - I	-	-	-	-	-	-
		Professional Elective - I	-	-	-	-	-	-
		Audit Course – I*	-	-	-	-	-	-
		Internal Combustion Engines Laboratory	2.4	2	2.4	-	2	3
	SEMESTER II	Electronic Engine Management Systems	2.8	2	3	-	2.6	-
		Internal Combustion Engine Design	3	3	2.8	-	2	-
		Computational Fluid Dynamics	2.6	1	3	-	3	-
		Instrumentation for Thermal Systems	2.6	-	2.6	-	3	3
		Professional Elective II	-	-	-	-	-	-
		Professional Elective III	-	-	-	-	-	-
		Audit Course - II*	-	-	-	-	-	-
		Analysis and Simulation Laboratory for Internal Combustion Engineering	2	1.2	2	2.6	2..3	3
		Mini project with seminar	2	2	2	1	1	-
YEAR II	SEMESTER III	Professional Elective IV	-	-	-	-	-	-
		Professional Elective V	-	-	-	-	-	-
		Open Elective	-	-	-	-	-	-
		Project Work - I	3	2	3	2	3	2
	SEMESTER IV	Project Work - II	3	3	3	3	3	3

PROFESSIONAL ELECTIVE COURSES	PO1	PO2	PO3	PO4	PO5	PO6
Automotive Technology	2.3	2	2.2	-	2.6	3
Advanced Fluids Engineering	2	-	3	3	-	-
Simulation of I.C. Engine Processes	3	2	3	2.8	3	2
Fuels and Lubricants	3	2	3	-	-	2
Aircraft and Space Propulsion	2.4	2	3	2	3	1
Bio Energy Technologies	3	3	3	-	2	2
Engine Pollution and Control	3	2	3	-	3	3
Hybrid and Electric Vehicles	2.5	2	3	1	2	2.5
Combustion and Reaction Kinetics in I.C. Engines	2.7	2.7	3	1.8	2.5	1
Energy Forecasting, Modeling and Project Management	2	3	3	2.6	-	1.5
Hydrogen and Fuel Cells Technologies	2.2	2.7	2.6	1.7	1.8	1.7
Boundary Layer Theory and Turbulence	2	2	1.8	1.7	2	-
Advanced Combustion Concepts in Engines	2.5	1.8	3	2	3	3
Manufacturing and Testing of Engine Components	2.6	1.6	2.6	1.8	2.4	2
Specialty Engines	2	1.5	2	-	2	2
Supercharging and Turbocharging	2	2	2.8	-	1.6	1.8
Advanced Energy Storage Technologies	2.6	3	2.8	2	2	1.8
Electrical Drives and Controls	2.5	2.4	2.6	2	1.6	2.5

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I TO IV SEMESTERS CURRICULA AND SYLLABUS
SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA4154	Advanced Numerical Methods	FC	4	0	0	4	4
2.	IC4151	Alternate Fuels for IC Engines	PCC	3	0	0	3	3
3.	IC4101	Combustion in Engines	PCC	3	0	0	3	3
4.	TE4151	Advanced Heat Transfer	FC	4	0	0	4	4
5.	TE4152	Advanced Thermodynamics	PCC	3	1	0	4	4
6.	RM4151	Research Methodology and IPR	RMC	2	0	0	2	2
7.		Professional Elective - I	PEC	3	0	0	3	3
8.		Audit Course – I*	AC	2	0	0	2	0
PRACTICAL								
9.	IC4111	Internal Combustion Engines Laboratory	PCC	0	0	4	4	2
			TOTAL	**24**	**1**	**4**	**29**	**25**

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	IC4252	Electronic Engine Management Systems	PCC	3	0	0	3	3
2.	IC4201	Internal Combustion Engine Design	PCC	3	0	0	3	3
3.	IC4291	Computational Fluid Dynamics	PCC	3	0	0	3	3
4.	IC4202	Instrumentation for Thermal Systems	PCC	3	0	0	3	3
5.		Professional Elective - II	PEC	3	0	0	3	3
6.		Professional Elective - III	PEC	3	0	0	3	3
7.		Audit Course - II*	AC	2	0	0	2	0
PRACTICAL								
8.	IC4211	Analysis and Simulation Laboratory for Internal Combustion Engineering	PCC	0	0	4	4	2
9.	IC4212	Mini project with seminar	EEC	0	0	2	2	1
			TOTAL	**20**	**0**	**6**	**26**	**21**

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Professional Elective - IV	PEC	3	0	0	3	3
2.		Professional Elective - V	PEC	3	0	0	3	3
3.		Open Elective	OEC	3	0	0	3	3
PRACTICAL								
4.	IC4311	Project Work - I	EEC	0	0	12	12	6
			TOTAL	**9**	**0**	**12**	**21**	**15**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICAL								
1.	IC4411	Project Work - II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE: 73

FOUNDATION COURSES (FC)

SI. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	MA4154	Advanced Numerical Mathematics	4	0	0	4	I
2.	TE4151	Advanced Heat Transfer	4	0	0	4	I

PROGRAM CORE COURSES (PCC)

SI. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	IC4151	Alternate Fuels for IC Engines	3	0	0	3	I
2.	IC4101	Combustion in Engines	3	0	0	3	I
3.	TE4152	Advanced Thermodynamics	3	1	0	4	I
4.	TE4152	Advanced Thermodynamics	0	0	4	2	I
5.	IC4252	Electronic Engine Management Systems	3	0	0	3	2
6.	IC4201	Internal Combustion Engine Design	3	0	0	3	2
7.	IC4291	Computational Fluid Dynamics	3	0	0	3	2
8.	IC4202	Instrumentation for Thermal Systems	3	0	0	3	2
9.	IC4211	Analysis and Simulation Laboratory for Internal Combustion Engineering	0	0	4	2	2

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	RM5151	Research Methodology and IPR	2	0	0	2	2

PROFESSIONAL ELECTIVES

SEMESTER I, ELECTIVE I

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	IC4001	Automotive Technology	PEC	3	0	0	3	3
2.	IC4002	Advanced Fluids Engineering	PEC	3	0	0	3	3
3.	IC4003	Simulation of I.C. Engine Processes	PEC	3	0	0	3	3
4.	IC4004	Fuels and Lubricants	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE II

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	IC4005	Aircraft and Space Propulsion	PEC	3	0	0	3	3
2.	EY4071	Bio Energy Technologies	PEC	3	0	0	3	3
3.	IC4091	Engine Pollution and Control	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE III

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	IC4092	Hybrid and Electric Vehicles	PEC	3	0	0	3	3
2.	IC4006	Combustion and Reaction Kinetics in I.C. Engines	PEC	3	0	0	3	3
3.	EY4092	Energy Forecasting, Modeling and Project Management	PEC	3	0	0	3	3
4.	TE4073	Hydrogen and Fuel Cell Technologies	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE IV

SL. NO.	COURSE CODE	COURSETITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	IC4071	Boundary Layer Theory and Turbulence	PEC	3	0	0	3	3
2.	IC4007	Advanced Combustion Concepts in Engines	PEC	3	0	0	3	3
3.	IC4008	Manufacturing and Testing of Engine Components	PEC	3	0	0	3	3
4.	IC4009	Specialty Engines	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE V

SL. NO.	COURSE CODE	COURSETITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	IC4010	Supercharging and Turbocharging	PEC	3	0	0	3	3
2.	EY4091	Advanced Energy Storage Technologies	PEC	3	0	0	3	3
3.	IC4011	Electrical Drives and Controls	PEC	3	0	0	3	3

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	AX4091	English for Research Paper Writing	2	0	0	0
2.	AX4092	Disaster Management	2	0	0	0
3.	AX4093	Constitution of India	2	0	0	0
4.	AX4094	நற்றமிழ் இலக்கியம்	2	0	0	0

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	IC4212	Mini Project with Seminar	EEC	0	0	2	2	1
2.	IC4311	Project Work - I	EEC	0	0	12	12	6
3.	IC4411	Project Work - II	EEC	0	0	24	24	12

LIST OF OPEN ELECTIVES FOR PG PROGRAMMES

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	OCE431	Integrated Water Resources Management	3	0	0	3
2.	OCE432	Water, Sanitation and Health	3	0	0	3
3.	OCE433	Principles of Sustainable Development	3	0	0	3
4.	OCE434	Environmental Impact Assessment	3	0	0	3
5.	OIC431	Blockchain Technologies	3	0	0	3
6.	OIC432	Deep Learning	3	0	0	3
7.	OBA431	Sustainable Management	3	0	0	3
8.	OBA432	Micro and Small Business Management	3	0	0	3
9.	OBA433	Intellectual Property Rights	3	0	0	3
10.	OBA434	Ethical Management	3	0	0	3
11.	ET4251	IoT for Smart Systems	3	0	0	3
12.	ET4072	Machine Learning and Deep Learning	3	0	0	3
13.	PX4012	Renewable Energy Technology	3	0	0	3
14.	PS4093	Smart Grid	3	0	0	3
15.	CP4391	Security Practices	3	0	0	3
16.	MP4251	Cloud Computing Technologies	3	0	0	3
17.	IF4072	Design Thinking	3	0	0	3
18.	MU4153	Principles of Multimedia	3	0	0	3
19.	DS4015	Big Data Analytics	3	0	0	3
20.	NC4201	Internet of Things and Cloud	3	0	0	3
21.	MX4073	Medical Robotics	3	0	0	3
22.	VE4202	Embedded Automation	3	0	0	3
23.	CX4016	Environmental Sustainability	3	0	0	3
24.	TX4092	Textile Reinforced Composites	3	0	0	3
25.	NT4002	Nanocomposite Materials	3	0	0	3
26.	BY4016	IPR, Biosafety and Entrepreneurship	3	0	0	3

MA4154 ADVANCED NUMERICAL METHODS L T P C
4 0 0 4

COURSE OBJECTIVES :

- To study various numerical techniques to solve linear and non-linear algebraic and transcendental equations.
- To compare ordinary differential equations by finite difference and collocation methods.
- To establish finite difference methods to solve Parabolic and hyperbolic equations.
- To establish finite difference method to solve elliptic partial differential equations.
- To provide basic knowledge in finite elements method in solving partial differential equations.

UNIT I ALGEBRAIC EQUATIONS 12

Systems of linear equations : Gauss elimination method – Pivoting techniques – Thomas algorithm for tri diagonal system – Jacobi, Gauss Seidel, SOR iteration methods – Conditions for convergence - Systems of nonlinear equations : Fixed point iterations, Newton's method, Eigenvalue problems : Power method and Given's method.

UNIT II ORDINARY DIFFERENTIAL EQUATIONS 12

Runge - Kutta methods for system of IVPs – Numerical stability of Runge - Kutta method – Adams - Bashforth multistep method, Shooting method, BVP: Finite difference method, Collocation method and orthogonal collocation method.

UNIT III FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATIONS 12

Parabolic equations : Explicit and implicit finite difference methods – Weighted average approximation - Dirichlet's and Neumann conditions – Two dimensional parabolic equations – ADI method : First order hyperbolic equations – Method of numerical integration along characteristics – Wave equation : Explicit scheme – Stability.

UNIT IV FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS 12

Laplace and Poisson's equations in a rectangular region : Five point finite difference schemes, Leibmann's iterative methods, Dirichlet's and Neumann conditions – Laplace equation in polar coordinates : Finite difference schemes – Approximation of derivatives near a curved boundary while using a square mesh.

UNIT V FINITE ELEMENT METHOD 12

Basics of finite element method : Weak formulation, Weighted residual method – Shape functions for linear and triangular element – Finite element method for two point boundary value problems, Laplace and Poisson equations.

TOTAL : 60 PERIODS

COURSE OUTCOMES :

After completing this course, students should demonstrate competency in the following skills:

- Solve an algebraic or transcendental equation, linear system of equations and differential equations using an appropriate numerical method.
- Solving the initial boundary value problems and boundary value problems using finite difference and finite element methods.
- Solving parabolic and hyperbolic partial differential equations by finite difference methods.
- Compute solution of elliptic partial differential equations by finite difference methods.

- Selection of appropriate numerical methods to solve various types of problems in engineering and science in consideration with the minimum number of mathematical operations involved, accuracy requirements and available computational resources.

REFERENCES :

1. Burden, R.L., and Faires, J.D., "Numerical Analysis – Theory and Applications", 9th Edition, Cengage Learning, New Delhi, 2016.
2. Gupta S.K., "Numerical Methods for Engineers",4th Edition, New Age Publishers, 2019.
3. Jain M. K., Iyengar S. R., Kanchi M. B., Jain, "Computational Methods for Partial Differential Equations", New Age Publishers ,1993.
4. Sastry, S.S., "Introductory Methods of Numerical Analysis", 5th Edition, PHI Learning, 2015.
5. Saumyen Guha and Rajesh Srivastava, "Numerical methods for Engineering and Science", Oxford Higher Education, New Delhi, 2010.
6. Smith, G. D., "Numerical Solutions of Partial Differential Equations: Finite Difference Methods", Clarendon Press, 1985.

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	-	-	2	-	-	-
2	-	-	2	-	-	-
3	-	2	3	-	-	-
4	2	2	3	2	-	-
5	2	3	3	2	-	-
Avg.	2	2.3	2.6	2	-	-

IC4151 ALTERNATE FUELS FOR IC ENGINES

L	**T**	**P**	**C**
3	**0**	**0**	**3**

COURSE OBJECTIVES:

1 To expose potential alternate fuels and their characteristics
2 To use appropriate synthetic fuels and fuel additives for better combustion characteristics
3 To utilise alcohol fuels effectively for lower emissions
4 To elaborate on the utilisation of Bio-Diesel and its types as a suitable fuel in CI engines
5 To utilise different gaseous fuels and predict their performance and combustion characteristics

UNIT I INTRODUCTION **9**

Availability, Suitability, Properties, Merits and Demerits of Potential Alternative Fuels – Alcohols, Biodiesel, Hydrogen, Liquefied Petroleum Gas, Natural Gas, Biogas, Fuel standards – ASTM & EN.

UNIT II SPECIAL AND SYNTHETIC FUELS **9**

Different synthetic fuels, Merits, and demerits, Dual, Bi-fuel and Pilot injected fuel systems, Fuel additives – types and their effect on performance and emission characteristics of engines, Flexi-fuel systems, Ethers - as fuel and fuel additives, properties and characteristics.

UNIT III ALCOHOL FUELS 9

Alcohols – Properties, Production methods and usage in engines. Blending, dual fuel operation, surface ignition, spark ignition and oxygenated additives. Performance, combustion and emission Characteristics in engines. Issues & limitation in alcohols

UNIT IV BIO-DIESEL FUELS 9

Vegetable oils and their important properties. Fuel properties characterization. Methods of using vegetable oils – Blending, preheating, Transesterification and emulsification – Performance, combustion and emission characteristics in diesel engines. Third generation biofuels, Ternary and Quaternary fuels, Issues & limitation of using vegetable oils in IC engines

UNIT V GASEOUS FUELS 9

Biogas, Natural gas, LPG, Hydrogen – Properties, problems, storage and safety aspects. Methods of utilisation in engines. Performance, combustion and emission characteristics in engines. Issues & limitation in Gaseous fuels

TOTAL:45 PERIODS

COURSE OUTCOMES :

The students will be able to

1 Expose potential alternate fuels and their characteristics
2 Use appropriate synthetic fuels and fuel additives for better combustion characteristics
3 Utilise alcohol fuels effectively for lower emissions
4 Elaborate on the utilisation of Bio-Diesel and its types as a suitable fuel in CI engines
5 Utilise different gaseous fuels and predict their performance and combustion characteristics

REFERENCES:

1. Keith Owen and Trevor Eoley, Automotive Fuels Handbook, SAE Publications, 1990.
2. Pundir B.P, I.C. Engines Combustion and Emission, 2010, Narosa Publishing House.
3. Pundir B.P , Engine Combustion and Emission, 2011, Narosa Publishing House Keith
4. Richard L. Bechtold, Automotive Fuels Guide Book, SAE Publications, 1997

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	1	-	2	-	1	-
2	2	2	2	-	2	-
3	2	2	2	-	1	-
4	2	3	3	-	2	2
5	2	3	2	-	2	2
Avg	1.8	2.5	2.2	-	1.6	2

IC4101 **COMBUSTION IN ENGINES** **L T P C**
3 0 0 3

COURSE OBJECTIVES

1. To make familiar with the design and operating characteristics of engines
2. To understand the basic principles of combustion
3. To gain knowledge in the principles of SI engine combustion
4. To understand the concepts of CI engine system
5. To understand the basic concepts of gas turbine combustion and the latest technological advances in low temperature combustion

UNIT I ENGINE BASICS 9

Principles of Engine operation – Torque and Power Characteristics – Intake and Exhaust Flows – Fuel Characteristics – ISO standards (Qualitative treatment only) Balancing, valve trains

UNIT II COMBUSTION PRINCIPLES 9

Combustion – Combustion equations, chemical equilibrium and Dissociation -Theories of Combustion - Flammability Limits - Reaction rates - Laminar and Turbulent Flame Propagation in Engines, Flame structure and speed - Chemical kinetics.

UNIT III COMBUSTION IN S.I. ENGINES 9

Stages of combustion, Cylinder pressure measurement and heat release analysis normal and abnormal combustion, knocking, Variables affecting Knock, Features and design consideration of combustion chambers, Types of combustion chambers., Cyclic variations, Lean burn combustion, Stratified charge combustion systems. Heat release correlations.

UNIT IV COMBUSTION IN C.I. ENGINES 9

Stages of combustion, and spray formation and characterization, air motion, swirl measurement, knock and engine variables, Features and design considerations of combustion chambers, delay period correlations, heat release correlations, Influence of the injection system on combustion, Direct and indirect injection systems.

UNIT V COMBUSTION IN GAS TURBINES & LOW TEMPERATURE COMBUSTION CONCEPTS IN I.C. ENGINE 9

Requirements - Combustion process – combustion chamber configurations – Flame stabilization – Design consideration of combustor – Factors affecting combustor performance – Emission and its control, Afterburners. Homogeneous charge compression ignition (HCCI) engine – Premixed charge compression ignition (PCCI) engine, Gasoline Direct Injection Compression Ignition (GDCI) engine, Reactivity controlled compression ignition (RCCI) engine – An introduction.

TOTAL:45 CREDITS

COURSE OUTCOMES

1. Given an engine design specification, predict performance and fuel economy trends
2. Apply basic concepts in the design of combustion systems
3. Able to design SI engine system
4. Develop an understanding of real world diesel engine design issues
5. Develop an ability to optimize future engine design for better fuel economy, performance, and emissions

REFERENCES

1. Ganesan, V, Internal Combustion Engines, Tata McGraw Hill Book Co., 2003.
2. John B. Heywood, Internal Combustion Engine Fundamentals, McGraw Hill Book, 1998.
3. Pundir B P, I.C. Engines Combustion and Emission, 2010, Narosa Publishing House.
4. Rajput R.K. Internal Combustion Engines, Laxmi Publications (P) Ltd, 2006.
5. Cohen, H, Rogers, G, E.C, and Saravanamuttoo, H.I.H., Gas Turbine Theory, Longman Group Ltd., 1980.

CO	PO					
	1	2	3	4	5	6
1	1	3	3	-	1	-
2	2	2	3	-	2	-
3	3	2	3	-	2	2
4	3	3	3	-	2	2
5	3	3	3	-	2	2
Avg	2.4	2.6	3	-	1.8	2

TE4151 ADVANCED HEAT TRANSFER L T P C
4 0 0 4

COURSE OBJECTIVES

1.To impart knowledge on conduction heat transfer associated with radiation.
2.To impart knowledge on the turbulent forced convective heat transfer.
3.To impart knowledge on the significance of Phase Change Heat Transfer and Mass Transfer.
4.To teach the heat exchanger design aspects including compact heat exchangers.
5.To impart knowledge on Mass transfer as an engineering phenomenon.

UNIT I CONDUCTION AND RADIATION HEAT TRANSFER 12

One dimensional energy equations and boundary condition - three-dimensional heat conduction equations - extended surface heat transfer- various pin profiles- pin optimization - transient conduction- conduction with moving boundaries - radiation in gases and vapour. Gas radiation and radiation heat transfer in enclosures containing absorbing and emitting media – interaction of radiation with conduction and convection

UNIT II TURBULENT FORCED CONVECTIVE HEAT TRANSFER 12

Momentum and energy equations - turbulent boundary layer heat transfer - mixing length concept - turbulence model – k Є model - analogy between heat and momentum transfer – Reynolds, Colburn, Prandtl turbulent flow in a tube - high speed flows.

UNIT – III PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGER 12

Condensation on bank of tubes - boiling – pool and flow boiling - heat Transfer Enhancement Techniques.

UNIT – IV HEAT EXCHANGERS 12

Heat Exchanger – Ɛ- NTU approach and design procedure – compact heat exchangers – Plate heat exchangers– Mini and Micro Channel heat exchangers, Heat transfer correlations for specific cases.

UNIT – V MASS TRANSFER 12

Mass transfer - vaporization of droplets - combined heat and mass transfers applications – Cooling Towers, Evaporative condensers, solar pond, Cooling and dehumidification systems – porous media heat transfer

TOTAL : 60 PERIODS

COURSE OUTCOMES:

1. Upon completion of this course, the students will be able to:
2. Analyse problems on heat transfer associated with conduction and convection and radiation through vapours and gases.
3. Analyse problems on turbulent heat transfer and also solve high speed flow problems.
4. Analyse problems on phase change heat transfer.
5. Estimate the performance of compact heat exchangers and also understand the use of correlations to predict heat transfer from specific devices
6. Understand and analyse the mass transfer associated with heat transfer in engineering systems

REFERENCES

1. Ghoshdastidar. P.S., Heat Transfer, Oxford University Press, 2004.
2. Holman.J.P., Heat Transfer, Tata Mc Graw Hill, 2002.
3. Incropera F.P. and DeWitt. D.P., Fundamentals of Heat & Mass Transfer, John Wiley & Sons, 2002.
4. Nag.P.K., Heat Transfer, Tata McGraw-Hill, 2002.
5. Ozisik. M.N., Heat Transfer – A Basic Approach, McGraw-Hill Co., 1985.
6. Yadav, R., Heat and Mass Transfer, Central Publishing House, 1995.
7. Yunus A.Cengal., Heat and Mass Transfer – A practical Approach, 3rd edition, Tata McGraw - Hill, 2007.

PO &CO Mapping:

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	2	1	3	-	-	-
2	2	2	3	-	-	-
3	2	1	3	-	-	-
4	2	2	3	-	-	-
5	2	2	2	-	-	-
Avg	2	1.6	2.6	-	-	-

TE4152 ADVANCED THERMODYNAMICS L T P C
3 1 0 4

COURSE OBJECTIVES:

- To achieve an understanding of basic principle and scope of thermodynamics.
- To predict the availability and irreversibility associated with the thermodynamic processes.
- To analyse the properties of ideal and real gas mixtures and to understand the basic concepts of thermal systems

UNIT I THERMODYNAMIC PROPERTY RELATIONS 12

Thermodynamic Potentials, Maxwell relations, Generalised relations for changes in Entropy, Internal Energy and Enthalpy, Generalised Relations for C_p and C_v, Clausius Clapeyron Equation, Joule Thomson Coefficient, Bridgeman Tables for Thermodynamic Relations.

UNIT II REAL GAS BEHAVIOUR AND MULTI-COMPONENT SYSTEMS 12

Equations of State (mention three equations), Fugacity, Compressibility, Principle of Corresponding States, use of generalised charts for enthalpy and entropy departure, fugacity coefficient, Lee-Kesler generalised three parameter tables. Fundamental property relations for systems of variable composition, partial molar properties, Real gas mixtures, Ideal solution of real gases and liquids, Equilibrium in multi-phase systems, Gibb's phase rule for non-reactive components.

UNIT III AVAILABILITY ANALYSIS 12

Introduction, Reversible work, Availability, Irreversibility and Second - Law Efficiency for a closed System and Steady-State Control Volume. Availability Analysis of Simple Cycles. Chemical availability of closed and control volume. Fuel Chemical availability, Evaluation of the availability of hydrocarbon fuels.

UNIT IV FUEL – AIR CYCLES AND THEIR ANALYSIS 12

Ideal Models of Engine Processes, Fuel–Air Cycle Analysis – SI Engine Cycle Simulation, CI Engine Cycle Simulation, Results of Cycle Calculations, Availability Analysis of Engine Processes – Availability Relationships – Entropy changes in Ideal Cycles – Availability Analysis of Ideal Cycles.

TOTAL : 60 PERIODS

UNIT V THERMO CHEMISTRY 12

Ideal gas laws and properties of Mixtures, Combustion Stoichiometry, Application of First Law of Thermodynamics – Heat of Reaction – Enthalpy of Formation – Adiabatic flame temperature. Second law of Thermodynamics applied to combustion – entropy, maximum work and efficiency Chemical equilibrium: - Equilibrium constant evaluation K_p&K_f, Equilibrium composition evaluation of ideal gas and real gas mixtures.

COURSE OUTCOMES:

On successful completion of this course the student will be able to

1. Apply the law of thermodynamics to thermal systems.
2. Analyse the actual thermodynamic cycles
3. Design and analyse a multi component thermodynamic system
4. Apply the thermodynamics concepts in automotive systems
5. Understand and analyse the combustion of different fuels

REFERENCES:

1. Kenneth Wark., J.R, Advanced Thermodynamics for Engineers, McGraw-Hill Inc., 1995.
2. K.Annamalai, I.K.Puri, M.A.Jog, Advanced Thermodynamics Engineering, Second Edition, CRC Press, 2011.
3. Advanced Thermodynamics, S.S. Thipse, Narosa Publishing Home Pvt. Ltd., 2013
4. Yunus A. Cengel and Michael A. Boles, Thermodynamics, McGraw-Hill Inc., 2006.
5. B.P. Pundir, I.C. engine combustion and emissions. Bejan, A., Advanced Engineering
6. Thermodynamics, John Wiley and Sons, 1988.
7. Holman,J.P., Thermodynamics, Fourth Edition, McGraw-Hill Inc., 1988.

PO & CO Mapping:

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	2	-	3	-	-	-
2	2	1	3	-	-	-
3	2	-	3	-	-	-
4	2	1	3	-	-	-
5	2	1	3	-	-	-
Avg	2	1	3	-	-	-

RM4151 RESEARCH METHODOLOGY AND IPR L T P C
2 0 0 2

UNIT I RESEARCH DESIGN 6

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II DATA COLLECTION AND SOURCES 6

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

UNIT III DATA ANALYSIS AND REPORTING 6

Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

UNIT IV INTELLECTUAL PROPERTY RIGHTS 6

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT V PATENTS 6

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

TOTAL :30 PERIODS

REFERENCES

1. Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012).
2. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
3. David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.
4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.

IC4111	INTERNAL COMBUSTION ENGINES LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To impart the knowledge on the practical aspects of Internal Combustion Engine Systems
- To impart the knowledge on the advanced engine technologies
- To understand the combustion, performance and emission behavior of SI and CI engine system at different load and speed conditions
- To understand the behavior of engine system at different operating conditions
- To understand the influence of after treatment system on emission reduction from engine systems
- To know the measurement of important fuel properties and its role

LIST OF EXPERIMENTS

1. Disassembly and Assembly of engines
2. Study of advanced diesel and gasoline engine technology engines
3. Study and drawing of engine components with dimensions.
4. Experimental investigation of combustion, performance and emission characteristics of spark ignition engine.
5. Experimental investigation of combustion, performance and emission characteristics of compression ignition engine
6. Determination of volumetric efficiency and equivalence ratio in a single cylinder D.I. Diesel engine.
7. Experimental study on the effect of fuel injection pressure on CI engine performance, combustion, and emission characteristics.
8. Experimental study on the effect of fuel injection timing on CI engine performance, combustion and emission characteristics.
9. Experimental study on the effect of preheating air and fuel on engine performance, combustion and emission characteristics.
10. Performance evaluation of After Treatment Systems
11. Determination of Flash and Fire point of various fuel blends.
12. Determination of Viscosity of various fuel blends.

LABORATORY REQUIREMENTS

1. Single or Multi Cylinder SI and CI Engine for disassembly and assembly
2. Engine Components for drawing and dimensioning
3. Single/ Multi-Cylinder S.I. Engine Test Rig with combustion and emission measurement facility

4. Single/ Multi-Cylinder C.I. Engines Test Rig with combustion and emission measurement facility
5. Exhaust Gas Analyser (To measure HC, CO, NOx, O_2, CO_2)
6. Smoke Meter
7. In cylinder Pressure Transducers, Charge Amplifiers, and crank angle encoders/crank sensor module with high speed data acquisition system
8. Open cup or Closed cup Flash and Fire Point Apparatus
9. Viscometer

COURSE OUTCOMES:

- Understand the various components of engine, its function, assembling of engine parts and working of advanced engine technologies
- Understand the procedures of conducting performance, combustion and emission test on engines and its significance
- Understand the method of calculating the volumetric efficiency and fuel-air ratio of an engine
- Understand the effect of various operating parameters of the engine on combustion, performance and emissions
- Understand the methods of calculating fuel properties

TOTAL: 60 PERIODS

PO &CO Mapping:

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	2	-	3	-	-	3
2	3	2	2	-	-	3
3	2	2	2	-	-	3
4	3	3	3	-	-	3
5	2	1	2	-	-	3
Avg	2.4	2	2.4	-	-	3

IC4252 ELECTRONIC ENGINE MANAGEMENT SYSTEMS

L	**T**	**P**	**C**
3	**0**	**0**	**3**

COURSE OBJECTIVES

1. To provide basic grounding on electronics
2. To learn the various sensors used in engine management systems
3. Give an overview of different types of ignition systems
4. To understand the significance of gasoline injection systems
5. To know the latest advancements in Diesel injection systems

UNIT I FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS 9

Components for Electronic Engine Management System- Open and Closed Loop Control Strategies- PID Control- Look Up Tables- Introduction to Modern Control Strategies Like Fuzzy Logic and Adaptive Control. Switches- Active Resistors- Transistors- Current Mirrors/Amplifiers- Voltage and Current References- Comparator- Multiplier. Amplifier- Filters- A/D and D/A Converters.

UNIT II SENSORS AND ACTUATORS 9

Inductive- Hall Effect- Thermistor- Piezo Electric- Piezoresistive- Based Sensors. Throttle Position- Mass Air Flow- Crank Shaft Position- Cam Position- Engine Speed Sensor- Exhaust Oxygen Level (Two Step- Linear Lambda and Wideband)- Knock- Manifold Temperature and Pressure Sensors. Solenoid- Relay (Four and Five Pin)- Stepper Motor

UNIT III SI ENGINE MANAGEMENT 9

Layout and Working of SI Engine Management Systems. Group and Sequential Injection Techniques. MPFI- GDI- Advantages of Electronic Ignition Systems. Types of Solid State Ignition Systems and Their Principle of Operation- Contactless (BREAKERLESS) Electronic Ignition System- Electronic Spark Timing Control

UNIT IV CI ENGINE MANAGEMENT 9

Fuel Injection System Parameters Affecting Combustion- Noise and Emissions in CI Engines. Electronically Controlled Unit Injection System. Common Rail Fuel Injection System. Working of Components Like Fuel Injector- Fuel Pump- Rail Pressure Limiter- Flow Limiter- EGR Valve.

UNIT V DIGITAL ENGINE CONTROL SYSTEM 9

Cold Start and Warm Up Phases- Idle Speed Control- Acceleration and Full Load Enrichment- Deceleration Fuel Cut-off. Fuel Control Maps- Open Loop and Closed Loop Control – Integrated Engine Control System- Electromagnetic Compatibility – EMI Suppression Techniques – Electronic Dash Board Instruments – Onboard Diagnosis System.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- Understand the basic electronic components and controls used in Sensors
- Explain the different types of sensors used in an automobile engine
- Describe the ignition and injection methods used in an SI engine
- Describe the fuel injection systems in a diesel engine and the emission control systems
- Explain the electronic systems used in the fuel control system and the dash board unit.

REFERENCES:

1. Understanding Automotive Electronics William B Ribbens, SAE 1998
2. Automobile Electronics by Eric Chowanietz SAE
3. Diesel Engine Management by Robert Bosch, SAE Publications, 3rd Edition, 2004
4. Gasoline Engine Management by Robert Bosch, SAE Publications, 2nd Edition, 2004

PO & CO Mapping:

CO	PO					
	1	2	3	4	5	6
1	2	2	3	-	2	-
2	3	2	3	-	3	-
3	3	2	3	-	3	-
4	3	2	3	-	3	-
5	3	-	3	-	2	-
Avg	2.8	2	3	-	2.6	-

IC4201 INTERNAL COMBUSTION ENGINE DESIGN L T P C
3 0 0 3

COURSE OBJECTIVES:

- To impart the basic engine design skills to the learners such that there is seamless transition to advanced design concepts
- To provide the basic grounding on the piston engine design philosophy
- To provide knowledge for the design of engine components
- To provide the knowledge about design philosophy of engine subsystems
- To enable the student to use CAD for preparing production drawings

UNIT I GENERALIA 9

Principle of similitude, Choice of material, Stress, Fatigue and Noise, Vibration and Harshness considerations (NVH)

UNIT II DESIGN OF MAJOR COMPONENTS 9

Piston system, Power Cylinder System, Connecting rod assembly, Crankshaft system, Valve Gearing, Stress analyses.

UNIT III DESIGN OF OTHER COMPONENTS / SUBSYSTEMS 9

Inlet and exhaust manifolds, cylinder block, cylinder-head, crankcase, engine mountings, gaskets, bearings, flywheel, turbocharger, supercharger, computer controlled fuel injection system, Basics of ignition, lubrication and cooling system design. Introduction to design of catalytic converters, particulate traps and EGR systems.

UNIT IV DESIGN SPECIFICS OF TWO-STROKE ENGINE SYSTEMS 9

Arrangement and sizing of ports, piston assembly, intake and exhaust system, scavenging, application to automotive gasoline and marine diesel engines.

UNIT V CONCEPTS OF COMPUTER AIDED DESIGN 9

Preparation of working drawings of designed components using CAD system.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The student will be able to

1. Select appropriate material for the engine components based on the functional requirements
2. Design engine components such as piston, connecting rod, crank shaft, and valves.
3. Design cylinder block, cylinder head, flywheels and subsystems
4. Design the ports and components for two stroke engines
5. Translate the design into drawings/models.

REFERENCES:

1. Design and Simulation of Four-Stroke Engines, Gordon P. Blair, Society of Automotive Engineers, Inc., USA, 1999.
2. Diesel Engine Reference Book, Second Edition, Bernard Challen and Rodica Baranescu (Editors), Butterworth-Heinemann, UK, 1999.
3. Internal Combustion Engine Design, A. Kolchin and V. Demidov, MIR Publishers, Moscow, 1984.
4. Internal Combustion Engine Handbook: Basics, Components, Systems and Perpectives, Richard van Basshuysen and Fred Schaefer (Editors), SAE International, USA and Siemes VDO Automotive, Germany, 2002.

5. Introduction to Engine Valve trains, Yushu Wang, SAE International, USA, 2007.
6. Vehicular Engine Design, Kevin L. Hoag, SAE International USA / Springer – Verlag, Wien, Austria, 2006.

PO &CO Mapping:

CO	PO					
	1	2	3	4	5	6
1	3	3	3	-	2	-
2	3	3	2	-	2	-
3	3	3	3	-	2	-
4	3	3	3	-	2	-
5	3	3	3	-	2	-
Avg	3	3	2.8	-	2	-

IC4291 COMPUTATIONAL FLUID DYNAMICS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- This course aims to introduce numerical modeling and its role in the field of heat, fluid flow and combustion. It will enable the students to understand the various discretisation methods and solving methodologies and to create confidence to solve complex problems in the field of heat transfer and fluid dynamics.
- To develop finite volume discretised forms of the governing equations for diffusion processes.
- To develop finite volume discretised forms of the convection-diffusion processes.
- To develop pressure-based algorithms for flow processes.
- To introduce various turbulence models, Large Eddy Simulation and Direct Numerical Simulation.

UNIT – I GOVERNING DIFFERENTIAL EQUATIONS AND DISCRETISATION TECHNIQUES **9**

Basics of Heat Transfer, Fluid flow – Mathematical description of fluid flow and heat transfer – Conservation of mass, momentum, energy and chemical species - Classification of partial differential equations – Initial and Boundary Conditions – Discretisation techniques using finite difference methods – Taylor's Series - Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

UNIT – II DIFFUSION PROCESSES: FINITE VOLUME METHOD **9**

Steady one-dimensional diffusion, Two- and three-dimensional steady state diffusion problems, Discretisation of unsteady diffusion problems – Explicit, Implicit and Crank-Nicholson's schemes, Stability of schemes.

UNIT – III CONVECTION-DIFFUSION PROCESSES: FINITE VOLUME METHOD **9**

One dimensional convection – diffusion problem, Central difference scheme, upwind scheme – Hybrid and power law discretization techniques – QUICK scheme.

UNIT – IV FLOW PROCESSES: FINITE VOLUME METHOD **9**

Discretisation of incompressible flow equations – Pressure based algorithms, SIMPLE, SIMPLER & PISO algorithms.

UNIT – V TURBULENCE MODELS 9

Turbulence – RANS equation - Algebraic Models, One equation model, Two equation models – k & standard k – ϵ model, Low Reynold number models of k- ϵ, Large Eddy Simulation (LES), Direct Numerical Simulation (DNS) - Introduction. Solving simple cases using standard CFD codes.

TOTAL:45 PERIODS

COURSE OUTCOMES:

On successful completion of this course the students will be able to:

- Analyse the governing equations and boundary conditions.
- Analyse various discretization techniques for both steady and unsteady diffusion problems.
- Analyse the various convection-diffusion problems by Finite-Volume method.
- Analyse the flow processes by using different pressure bound algorithms.
- Select and use the different turbulence models according to the type of flows.

PO &CO Mapping:

CO	PO					
	1	2	3	4	5	6
1	2	1	3	-	-	-
2	2	1	3	-	-	-
3	3	1	3	-	3	-
4	3	1	3	-	3	-
5	3	1	3	-	3	-
Avg	2.6	1	3	-	3	-

REFERENCES:

1. Versteeg and Malalasekera, N, “An Introduction to computational Fluid Dynamics The Finite Volume Method,” Pearson Education, Ltd., Second Edition, 2014.
2. Ghoshdastidar, P.S., “Computer Simulation of Flow and Heat Transfer”, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1998.
3. Muralidhar, K., and Sundararajan, T., “Computational Fluid Flow and Heat Transfer”, Narosa Publishing House, New Delhi, 2003.
4. Subas and V.Patankar “Numerical heat transfer fluid flow”, Hemisphere Publishing Corporation, 1980.
5. JiyuanTu, Guan Heng Yeoh, Chaogun Liu, “Computational Fluid Dynamics A Practical Approach” Butterworth – Heinemann An Imprint of Elsevier, Madison, U.S.A., 2008
6. John D. Anderson. JR. “Computational Fluid Dynamics the Basics with Applications” McGraw-Hill International Editions, 1995.

IC4202 INSTRUMENTATION FOR THERMAL SYSTEMS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1 To expose students to basic characteristics of measurement parameters
2 To enable the students use appropriate measurement system for various applications
3 To enable the students to measure thermo physical properties of solids and fuels
4 To elaborate the students on the need, types of control systems and components of a control system
5 To design a suitable control system for various thermal systems

UNIT I MEASUREMENT CHARACTERISTICS 9

Introduction to measurements, Errors in measurements, Statistical analysis of data, Regression analysis, correlation, estimation of uncertainty and presentation of data, design of experiments – Experimental design factors and protocols

UNIT II MEASUREMENTS IN THERMAL SYSTEMS 9

Basic Electrical measurements, Transducers and its types, Signal conditioning and processing - Measurement of temperature, pressure, velocity, flow – basic and advanced techniques, and radiation properties of surfaces

UNIT III MEASUREMENT OF FUEL PROPERTIES AND POLLUTANTS 9

Thermo / Physical / Chemical and transport properties of solids, liquids and gaseous fuels, Analysers – Flame Ionisation Detector, Non-Dispersive Infrared Analyser, Chemiluminescent detector, Smoke meters, and Gas chromatography

UNIT IV CONTROL SYSTEMS, COMPONENTS AND CONTROLLERS 9

Introduction, Open and closed loop control systems, Transfer function. Types of feedback and feedback control system characteristics – Control system parameters – DC and AC servomotors, servo amplifier, potentiometer, synchro transmitters, synchro receivers, synchro control transformer, stepper motors - Continuous, Discontinuous and Composite control modes – Analog and Digital controllers

UNIT V DESIGN OF MEASUREMENT AND CONTROL SYSTEMS 9

Data logging and acquisition - Sensors for error reduction, elements of computer interfacing, Timers, and Counters, design of measurement and control systems for specific applications - Fault finding – Computer based controls

TOTAL:45 PERIODS

COURSE OUTCOMES:

The students will be able to

1 Understand the fundamental concepts of measurement parameters
2 Select the suitable type of sensor for a measuring a fundamental parameter
3 Use appropriate devices to measure different properties of solids and fuels
4 Distinguish between measurement and control systems, and use appropriate control system for an application
5 Construct a complete control system for a thermal application

CO	PO					
	1	2	3	4	5	6
1	2	-	2	-	-	-
2	2	-	2	-	-	-
3	3	-	3	-	3	-
4	3	-	3	-	3	-
5	3	-	3	-	3	3
Avg	2.6	-	2.6	-	3	3

REFERENCES:

1) Bolton. W, Industrial Control & Instrumentation, Universities Press, Second Edition, 2001.
2) Doblin E.O, Measurement System Application and Design, Second Edition, McGraw Hill, 1978.
3) Holman, J.P., Experimental methods for Engineers, Tata McGraw-Hill, 7th Ed.2001.

4) Morris.A.S, Principles of Measurements and Instrumentation, Prentice Hall of India, 1998.
5) Nakra, B.C., Choudhry K.K., Instrumentation, Measurements and Analysis Tata McGraw Hill, NewDelhi, Second Edition 2003
6) Norman A. Anderson, Instrumentation for Process Measurement and Control, Third Edition, CRC Press,1997
7) Venkatesan S.P, Mechanical Measurements, AnePublications, Second edition, 2015.

IC4211 ANALYSIS AND SIMULATION LABORATORY FOR INTERNAL COMBUSTION ENGINEERING

L	T	P	C
0	0	4	2

COURSE OBJECTIVE:

Use of standard application software for solving engine flow and combustion problems

1. Engine intake flow analysis using different Port shapes
2. Engine exhaust flow analysis
3. Engine in-cylinder cold flow analysis for the given engine sector model
4. Fuel spray studies
5. Combustion and emission analysis
6. Engine hood cooling analysis

NOTE: The above exercises are only guidelines to maintain the standard for teaching and conduct of examination.

SIMULATION LAB – REQUIREMENT:

1. Software - Modeling software like Gambit, Star-CD es-ice, Star-CD enabled CFM, CCM+,DARS BASIC, DARS CFD, STAR-CD, Equation solving software like MATLAB, Engg equation solver
2. Every student in a batch must be provided with a terminal
3. Hardware is compatible with the requirement of the above software.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

The students will be able to

1 Design and analyse the flow pattern in an engine inlet and exhaust system
2 Perform modeling of a cooling system of an engine
3 Use the appropriate tools/ software packages for design, meshing and analysis
4 Simulate the emission from the engine exhaust
5 Analysis of the fuel and combustion system

PO &CO Mapping:

CO	PO					
	1	2	3	4	5	6
1	1	1	2	2	-	-
2	2	1	2	2	-	-
3	2	1	-	3	3	-
4	3	1	2	3	2	-
5	2	2	2	3	2	3
Avg	2	1.2	2	2.6	2..3	3

IC4212 **MINI PROJECT WITH SEMINAR** **L T P C**
0 0 2 1

COURSE OBJECTIVES:

- During the seminar session each student is expected to prepare and present a topic on Energy related issues / technology, for a duration of about 30 minutes.
- In a session of three periods per week, 4 students are expected to present the seminar.
- A faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain attendance also.
- Students are encouraged to use various teaching aids such as overhead projectors, power point presentation and demonstrative models.

TOTAL: 30 PERIODS

IC4311 **PROJECT WORK - I** **L T P C**
0 0 12 6

COURSE OBJECTIVES:

- A research project topic may be selected either from published lists or from the creative ideas of the students themselves in consultation with their project supervisor.
- To improve the student research and development activities.

EVALUATION

Project work evaluation is based on Regulations of Credit system University Departments - Post graduate programmes of Anna University

TOTAL: 90 PERIODS

COURSE OUTCOME:

The students' would apply the knowledge gained from theoretical and practical courses in solving problems, so as to give confidence to the students to be creative, well planned, organized, coordinated in their project work phase – II.

PO &CO Mapping:

CO	PO					
	1	2	3	4	5	6
1	3	2	3	2	3	2
Avg	3	2	3	2	3	2

IC4411 **PROJECT WORK - II** **L T P C**
0 0 24 12

COURSE OBJECTIVES:

- The objective of the research project work is to produce factual results of their applied research idea in the thermal Engineering, from phase – I.
- The progress of the project is evaluated based on a minimum of three reviews.
- The review committee may be constituted by the Head of the Division.
- A project report is required at the end of the semester. The project work is evaluated jointly by external and internal examiners constituted by the Head of the Division based on oral presentation and the project report
- To improve the student research and development activities.

EVALUATION

- Project work evaluation is based on Regulations of Credit system Affiliated Colleges- Post graduate programmes of Anna University

TOTAL = 180 PERIODS

COURSE OUTCOME:

The students would apply the knowledge gained from theoretical and practical courses in solving problems, so as to give confidence to the students to be creative, well planned, organized, coordinated project outcome of the aimed work.

PO &CO Mapping:

CO	PO					
	1	2	3	4	5	6
1	3	3	3	3	3	3
Avg	3	3	3	3	3	3

IC4001 AUTOMOTIVE TECHNOLOGY

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To distinguish different types of chassis, frames and body and its component design.
- To introduce the concept of aerodynamics in automobiles.
- To estimate the forces acting on vehicle during turning and acceleration.
- To identify various safety technologies incorporated in automobiles.
- To introduce the need for alternative power plants and its types.

UNIT I VEHICLE STRUCTURE 9

Basic construction of Chassis, types of Chassis layout, types of Body, types of frames, Loads acting on vehicle frame, materials for frames, testing of frames, Bharat New Vehicle Safety Assessment Program (BNVSAP) - Protocols.

UNIT II AUTOMOTIVE AERODYNAMICS 9

Automobile drag and types. Types of forces and moments – drag coefficient of automobiles – low drag profiles. Drag reduction techniques in cars and trucks. Wind Tunnel Testing & Measurement of Drag.

UNIT III VEHICLE DYNAMICS 9

Vehicle Dynamics – Steady state handling characteristics, Types of forces acting on a vehicle body, Roll centre, Roll axis, Vehicle under side forces, Calculation of Maximum acceleration, Reaction forces for different drives, Stability Control.

UNIT IV SAFETY TECHNOLOGIES 9

Antilock Braking System, Electronic Brake Force Distribution, Dual stage Airbag, Seatbelt Pre-tensioner, Dynamic Radar Cruise Control, Traction control system, Pre-Collision System, Automatic High Beam, Adaptive Headlights, Daytime Running Lamp, Active headrests, Crumple Zone

UNIT V ALTERNATIVE POWER PLANT 9

Need for Alternative power plants, Types of Hybrid Electric Vehicles – Series, parallel, split – parallel, series – parallel, Advantages and Disadvantages. Electric Vehicles – Classification and its characteristics. Power split device – Energy management system - Batteries, Fuel cells – Types, construction, principle of operation and characteristics.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

On successful completion of the course, the students will be able to:

1. Categorise various vehicles based on its chassis, body and know how vehicle testing is carried out.
2. Compute drag coefficients and recognise the need for drag reduction in automobiles.
3. Determine the various forces acting on the automobile and its effect while in motion.
4. Recognise the various safety technologies incorporated in automobiles and their pros and cons.
5. Distinguish the working of various alternate power plants for automobiles.

REFERENCES:

1. Joseph Heitner, “Automotive Mechanics”, 2nd Edition, CBS, 2006.
2. William H. Crouse, Donald L. Anglin, Automotive Mechanics, 10th Edition, McGraw Hill Education (India) Private Limited, 2006.
3. Heinz Heisler, “Advanced Vehicle Technology”, Butterworth-Heinemann, 2002
4. R.B. Gupta, Automobile Engineering, Satya Prakashan, 1993.
5. Hans B Pacejka, Tyre and Vehicle Dynamics, 2nd edition, SAE International, 2005
6. John C. Dixon, Tyres, Suspension, and Handling, 2nd Edition, Society of Automotive Engineers Inc, 1996
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8. Hucho, W.H., Aerodynamics of Road vehicles, Butterworths Co Ltd., 4th Edition, SAE, 1998.
9. Iqbal Husain, Electric and Hybrid Vehicles, Design Fundamentals, CRC Press, 2003.
10. M. Ehsani, Y. Gao, S. Gay and A. Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, CRC Press, 2005.

PO &CO Mapping:

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	2	-	2	-	2	-
2	2	-	3	-	2	-
3	-	-	2	-	3	-
4	3	2	2	-	3	-
5	-	-	2	-	3	3
Avg	2.3	2	2.2	-	2.6	3

IC4002 ADVANCED FLUIDS ENGINEERING L T P C
3 0 0 3

COURSE OBJECTIVES:

1) To introduce the concept of different types of fluid flow and its characteristics.
2) To model flows using analytical techniques.
3) To introduce the effect of boundary layers on a flow and its effect on the flow properties.
4) To distinguish the effects of pressure waves, flame propagation and special types of flow in engine.
5) To introduce different methods of flow visualisation techniques with its instrumentation.

UNIT I INTRODUCTION TO FLUID FLOW 9

Lagrangian and Eulerian approach, Newtonian Fluids, Non-Newtonian fluids, stokes' law of viscosity, Navier – Stokes Equations, Compressible and Incompressible Flows, Ideal flows and Boundary layer flows – Introduction, Effect of swirl, squish and tumble flows in mixing of fuel and air. Characteristics of Low, Moderate and High Reynold number flows.

UNIT II POTENTIAL FLOW 9

Streamlines, Path lines, streak lines and time lines, Stream function and Velocity Potential function – Source, Sink and Doublet. Combination of flows - Rankine half body, Rankine full body, Vorticity, Rotational and Irrotational flows, Flow past a cylinder.

UNIT III BOUNDARY LAYERS 9

Laminar Boundary Layers – Approximate Integral Methods, Asymptotic Expansions and Triple Deck theory, 3D laminar boundary layer, unsteady boundary layers and Turbulent Boundary Layers. Velocity Profiles, Turbulent boundary layer on a flat plate, Turbulence Modelling – Introduction, Free Turbulence of Jets, wakes and mixing layers.

UNIT IV COMPRESSIBLE FLOW AND SPEICAL FLOWS 9

Compressible flow – Introduction, stagnation state, Finite pressure waves – effect on engine, Hagen – Poiseuille Flow and Couette Flow – applications in engine.

UNIT V FLOW VISUALISATION 9

Instrumentation - Schlieren photography – Laser Velocimetry – Illuminated Particle Visualisation Holography – Particle Image Velocimetry. Other Cold flow and combustion visualisation techniques. Numerical flow visualisation – Introduction.

TOTAL : 45 PERIODS

COURSE OUTCOMES :

On successful completion of this course, the students will be able to:

1) Use different approximations for the flow problem under consideration.
2) Model basic flows and develop codes for numerical flow visualization
3) Apply the concepts of viscous fluid flow for prediction of thickness of boundary layer and to predict overall flow characteristics.
4) Analyse compressible flow in engine like compression, knocking.
5) Select different flow visualisation techniques required for their experiments.

REFERENCES:

1. Ronald L. Panton, Incompressible flow, 3rd Edition, Wiley, 2005.
2. K. Muralidhar and G. Biswas, Advanced Engg. Fluid Mechanics, Narosa Publishing House, 2005.
3. Frank M. White, Viscous Fluid Flow, 3rd Edition, McGraw Hill, 2011.
4. I.G. Currie, Fundamental Mechanics of fluids, 4th Edition, McGraw Hill 2011.

5. F.P. Incropera and B. Lavine, Fundamentals of Heat and Mass Transfer, 7th Edition, Willey, 2011.
6. Welty, C. Wicks, Fundamentals of Momentum, Heat and Mass Transfer, 4th Edition, Wiley 2009.
7. J.P. Holman, Experimental Methods for Engineers, McGraw – Hill Inc., 2001.
8. Wolfgang Merzkirch, Flow Visualisation, 2nd Edition, Academic Press, 1987.
9. Marshall B. Long, Optical Methods in flow and Particle Diagnosis, Society of Photo Optics, 1989.
10. B.H. Lakshmana Gowda, A Kaleidoscopic view of Fluid Flow Phenomena, Wiley Eastern, 1992.
11. Will Schroeder, Ken Martin and Bill Lorensen, An Object – Oriented Approach to 3D Graphics, 2ndEdition, Prentice Hall, 1998.

CO	PO					
	1	2	3	4	5	6
1	2	-	3	-	-	-
2	2	-	3	-	-	-
3	2	-	3	-	-	-
4	2	-	3	3	-	-
5	2	-	3	3	-	-
Avg	2	-	3	3	-	-

IC4003 SIMULATION OF I.C. ENGINE PROCESSES L T P C
3 0 0 3

COURSE OBJECTIVES:

- To impart knowledge on simulation of various engine processes used in prime movers and power plants.
- To learn the simulation of engine combustion based on first and second law of thermodynamics.

UNIT I SIMULATION PRINCIPLES 9

First and second laws of thermodynamics – Estimation of properties of gas mixtures - Structure of engine models – Open and closed cycle models - Cycle studies. Chemical Reactions, First law application to combustion, Heat of combustion – Adiabatic flame temperature. Hess Law Lechatlier principle. Heat transfer in engines – Heat transfer models for engines. Simulation models for I.C. Engines. (Ideal and actual cycle simulation) Chemical Equilibrium and calculation of equilibrium composition.

UNIT II SIMULATION OF COMBUSTION IN SI ENGINES 9

Combustion in SI engines, Flame propagation and velocity, Single zone models – Multi zone models – Mass burning rate, Turbulence models – One dimensional model – Chemical kinetics modeling – Multidimensional models, Flow chart preparation.

UNIT III SIMULATION OF COMBUSTION IN CI ENGINES 9

Combustion in CI engines Single zone models – Premixed-Diffusive models – Wiebe' model – Whitehouse way model, Two zone models - Multizone models- Meguerdichian and Watson's model, Hiroyasu's model, Lyn's model – Introduction to Multidimensional and spray modeling, Flow chart preparation.

UNIT IV SIMULATION OF TWO STROKE ENGINES 9

Thermodynamics of the gas exchange process - Flows in engine manifolds – One dimensional and multidimensional models, Flow around valves and through ports Models for scavenging in two stroke engines – Isothermal and non-isothermal models, Heat Transfer and Friction.

UNIT V SIMULATION OF GAS TURBINE COMBUSTORS 9

Gas Turbine Power plants – Flame stability, Combustion models for Steady Flow Simulation – Emission models. Flow chart preparation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course the student will be able to

1. Simulate the SI engine processes
2. Simulate the CI engine processes
3. Simulate advance combustion concepts
4. Simulate the gas turbine processes
5. Simulate the different engine processes in 2 and 4 stroke engines**.**

REFERENCES:

1. Ashley S. Campbell, Thermodynamic Analysis of Combustion Engines, Krieger Publication co, 1985.
2. V.Ganesan, Computer Simulation of Spark Ignition Engine Processes, Universities Press, 2000.
3. V V. Ganesan, Computer Simulation of C.I. Engine Processes, Universities Press, 2000.
4. Cohen H. Rogers GEC. – Gas Turbine Theory – Pearson Education India Fifth edition, 2001.
5. Bordon P. Blair, The Basic Design of two-Stroke engines, SAE Publications, 1990.
6. Horlock andWinterbone, the Thermodynamics and Gas Dynamics of Internal Combustion Engines, Vol. I & II, Clarendon Press, 1986.
7. J.I.Ramos, Internal Combustion Engine Modeling, Butterworth – Heinemann ltd, 1999.
8. J.N.Mattavi and C.A.Amann, Combustion Modeling in Reciprocating Engines, Plenum Press,1980.

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	3	2	3	3	3	2
2	3	2	3	3	3	2
3	3	2	3	3	3	2
4	3	2	3	3	3	2
5	3	2	3	2	-	2
Avg	3	2	3	2.8	3	2

IC4004	FUELS AND LUBRICANTS	L	T	P	C
		3	0	0	3

OBJECTIVES:

1. To identify the processes behind fuel extraction system.
2. To understand the theory behind lubrication
3. To study the properties of lubricants.
4. To elaborate the properties of fuels used in IC engines.
5. To understand the need of fuel rating

UNIT I MANUFACTURE OF FUELS AND LUBRICANTS 9

Structure of petroleum, refining process, fuels, thermal cracking, catalytic cracking, polymerization, alkylation, isomerisation, blending, products of refining process. Manufacture of lubricating oil base stocks, manufacture of finished automotive lubricants.

UNIT II THEORY OF LUBRICATION 9

Engine friction: introduction, total engine friction, effect of engine variables on friction, hydrodynamic lubrication, elasto hydrodynamic lubrication, boundary lubrication, bearing lubrication, functions of the lubrication system, introduction to design of a lubricating system

UNIT III PROPERTIES AND TESTING OF LUBRICANTS 9

Specific requirements for automotive lubricants, oxidation deterioration and degradation of lubricants, synthetic lubricants, classification of lubricating oils, properties of lubricating oils, tests on lubricants. Grease, classification, properties, test used in grease.

UNIT IV PROPERTIES AND TESTING OF FUELS AND COMBUSTION 9

Thermo-chemistry of fuels, properties and testing of fuels, relative density, calorific value, flash point, fire point, distillation, vapour pressure, spontaneous ignition temperature, viscosity, pour point, flammability, ignitability, diesel index, API gravity, aniline point, carbon residue, copper strip corrosion etc. combustion in SI and CI Engine

UNIT – V ADDITIVES FOR LUBRICANTS AND FUELS 9

Additive - mechanism, requirements of additive, petrol fuel additives, diesel fuel additives and additive mechanism for lubricants. Introduction to Nano fluids

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Identify the processes behind fuel extraction system.
2. Understand the theory behind lubrication
3. Study the properties of lubricants.
4. Elaborate the properties of fuels used in IC engines.
5. Understand the need of fuel rating and additives.

REFERENCES:

1. Ganesan. V., “Internal Combustion Engineering”, Tata McGraw-Hill Publishing Co., New Delhi, 2003.
2. M.L. Mathur, R.P.Sharma “A course in internal combustion engines”, Dhanpatrai publication, 2003.
3. A.R.Lansdown – Lubrication – A practical guide to lubricant selection – Pergamon press – 1982.
4. Raymond.C.Gunther – Lubrication – Chilton Book Co., - 1971.
5. Brame, J.S.S. and King, J.G. – Fuels – Solids, Liquids, Gaseous.
6. Francis, W – Fuels and Fuel Technology, Vol. I & II
7. Hobson, G.D. &Pohl.W- Modern Petroleum Technology

CO	PO					
	1	2	3	4	5	6
1	-	2	3	-	-	-
2	-	2	3	-	-	-
3	3	2	3	-	-	-
4	3	2	3	-	-	-
5	3	2	3	-	-	-
Avg	3	2	3	-	-	-

IC4005 AIRCRAFT AND SPACE PROPULSION

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To familiarize with the concept of compressible flow and effect of shock waves.
- To recognize and distinguish the working of various aircraft engines.
- To design and match aircraft components and calculate its performance.
- To gain insight on the working principle of rocket engines, different feed systems, propellants and their properties and dynamics of rocket.
- To design rockets for various space applications and calculate rocket performance.

UNIT I WAVE MOTION AND SHOCK WAVES 9

Wave motion, Mach waves and Mach cone, sound waves, Shock waves – Normal and Oblique, Relation of physical properties across a shock, Deflection Relations, Method of Characteristics – Applications, Problems, Expansion Waves – Introduction.

UNIT II AIR-BREATHING ENGINES 9

Theory of Aircraft propulsion – Different propulsion systems – Turboprop – Turbojet, Turbojet with after burner, Turbo fan and Turbo shaft, Ramjet, Scramjet. Methods of Thrust augmentation - Thrust vector control, Fuels for jet engines.

UNIT III THERMODYNAMICS OF AIRCRAFT ENGINES 9

Engine - Aircraft matching – Design of inlets and nozzles – Performance characteristics of Ramjet, Turbojet, Scramjet and Turbofan engines, Problems.

UNIT IV ROCKET PROPULSION 9

History of rocket propulsion, Deflagration & Detonation, Combustion in solid and liquid propellants rockets, classification of propellants and propellant injection systems – Non equilibrium expansion and supersonic combustion – Propellant feed systems – Reaction Control Systems - Rocket heat transfer. Electric propulsion – classification- electro thermal – electro static – electromagnetic thrusters- geometries of Ion thrusters- beam/plume characteristics – hall thrusters.

UNIT V ROCKET STAGING AND PERFORMANCE 9

Rocket equations – Escape and Orbital velocity – Multi-staging of Rockets – Space missions – Performance characteristics of rockets – Losses and efficiencies, Design of Rockets.

TOTAL : 45 PERIODS

COURSE OUTCOMES :

On successful completion of this course, the students will be able to:

1) Use concepts of compressible flow to design variable area ducts for the given conditions.
2) Identify various aircraft engines and know its inner workings with emphasis on its limitations and applications.
3) Mix and match various components of an aircraft engine for its design conditions.
4) Classify various rocket engines based on its type and design it for requirements.
5) Use orbital mechanics principles to design payload for rockets.

CO	PO					
	1	2	3	4	5	6
1	1	2	3	-	-	-
2	-	2	3	-	3	-
3	-	2	3	-	-	-
4	3	2	3	-	-	-
5	3	2	3	3	3	1
Avg	2.4	2	3	3	3	1

REFERENCES:

1. Philip G. Hill and Carl R. Peterson, Mechanics and Thermodynamics of Propulsion, Second Edition, Addition – Wesley Publishing Company, New York, 2009.
2. Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H, Gas Turbine Theory, Longman,1989
3. G.C. Oates, "Aerothermodynamics of Aircraft Engine Components", AIAA Education Series, 1985.
4. S. M. Yahya, Fundamentals of Compressible Flow. Third edition, New Age International Pvt. Ltd,2003.
5. George P. Sutton, Oscar Biblarz. Rocket Propulsion Elements, John Wiley & Sons, 8th Edition, 2010.
6. Ramamurthy, Rocket Propulsion, Pan Macmillan (India) Ltd, 2010.
7. W.P.Gill, H.J.Smith& J.E. Ziurys, "Fundamentals of Internal Combustion Engines as applied to Reciprocating, Gas turbine & Jet Propulsion Power Plants", Oxford & IBH Publishing Co., 1980.

EY4071 BIO ENERGY TECHNOLOGIES L T P C

3 0 0 3

COURSE OBJECTIVES:

1. To learn availability of biomass, methods of biomass analysis and study of characteristics.
2. To create awareness on the technologies available for conversion of biomass to energy in terms of its technical competence and economic implications.
3. To impart knowledge on stoichiometry and combustion of biofuels and costing of biomass technologies
4. To elucidate the thermochemical conversion methods of biomass and its use in engines
5. To provide insight to the possibilities of producing liquid fuels form biomass

UNIT- I INTRODUCTION 9

Biomass: types–advantages and drawbacks–Indian scenario–characteristics–carbon neutrality–conversion mechanisms–fuel assessment studies–densification technologies Comparison with coal – Proximate & Ultimate Analysis – Thermo Gravimetric Analysis – Differential Thermal Analysis– Differential Scanning Calorimetry

UNIT- II BIOMETHANATION 9

Microbial systems – phases in biogas production – parameters affecting gas production – effect of additives on biogas yield – possible feed stocks. Biogas plants – types – design – constructional details and comparison – biogas appliances – burner, luminaries and power generation – effect on engine performance.

UNIT- III COMBUSTION 9

Perfect, complete and incomplete combustion-stoichiometric air requirement for biofuels-equivalence ratio – fixed Bed and fluid Bed combustion – fuel and ash handling systems – steam cost comparison with conventional fuels.

UNIT- IV GASIFICATION, PYROLYSIS AND CARBONISATION 9

Chemistry of gasification- types–comparison–application–performance evaluation–economics – dual fuelling in IC engines – 100 % Gas Engines – engine characteristics on gas mode – gas cooling and cleaning systems – Pyrolysis – Classification – process governing parameters – Typical yield rates. Carbonization Techniques–merits of carbonized fuels

UNIT- V LIQUIFIED BIOFUELS 9

History of usage of Straight Vegetable Oil (SVO) as fuel – Biodiesel production from oil seeds, waste oils and algae – Process and chemistry – Biodiesel health effects / emissions /performance. Production of alcoholic fuels (methanol and ethanol) from biomass –engine modifications

TOTAL:45 PERIODS

COURSE OUTCOMES:

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

1. Estimate the availability of surplus biomass and study the characteristics
2. Design a biogas plant for different bioenergy sources
3. Determine and compare the cost of steam generation from biofuels with conventional fuels.
4. Analyze the influence of process governing parameters in thermo chemical conversion of biomass and in internal combustion engines
5. Evaluate the production of liquid biofuels for power generation from biomass

REFERENCES

1. David Boyles,Bio Energy Technology Thermodynamics and costs, Ellis Horwood Chichester,1984.
2. Iyer PV Retal, Thermo chemical Characterization of Biomass, MNES
3. KhandelwalKC, Mahdi SS, Biogas Technology–A Practical Handbook,Tata McGraw Hill,1986
4. Maheswari,R.C. BioEnergy for Rural Energisation, Concepts Publication,1997
5. Tom B Reed, Biomass Gasification–Principles and Technology, Noyce Data Corporation,1981.
6. Bioenergy: Biomass to Biofuels and Waste to Energy, Academic Press,2020
7. David C. Dayton , Thomas D. Foust ,Analytical Methods for Biomass Characterization and Conversion (Emerging Issues in Analytical Chemistry), Elsevier,2019

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	1		1		3	
2	2		2		2	
3	2		2		1	
4	2		2		1	
5	2		2		1	
Avg.	1.8		1.8		1.6	

IC4091 ENGINE POLLUTION AND CONTROL L T P C
3 0 0 3

COURSE OBJECTIVES

1. To provide an insight about effect of engine out emissions on human health and environment
2. To impart the knowledge on various pollutant species formations in SI and CI engine
3. To divulge about various emission measurement techniques in engines and its significance
4. To provide a discernment about various emission control methods
5. To impart the knowledge about international and national driving cycles and emission standards

UNIT I AIR POLLUTION – ENGINES 9

Atmospheric pollution from automotive, stationary engines and gas turbines, Global warming – Greenhouse effect, Effects of engine pollution on human health and environment.

UNIT II POLLUTANT FORMATION 9

Formation of Oxides of nitrogen, Carbon monoxide, Hydrocarbon, Aldehydes, Smoke and Particulate matter emissions. Effects of Engine design and operating variables on emission formation, Noise pollution.

UNIT III EMISSION MEASUREMENT TECHNIQUES 9

CO, CO2 - Non dispersive infrared gas analyzer, NOx - Chemiluminescent analyzer, HC - Flame ionization detector, Smoke – Opacity and filter paper measurements, Particulate Matter – Full flow and Partial flow dilution tunnel, Gas chromatography, Noise measurement.

UNIT IV EMISSION CONTROL TECHNIQUES 9

Engine design modifications, Fuel modification, Evaporative emission control, EGR, Air injection, Thermal reactors, Water injection, Common rail direct injection and Gasoline direct injection system, After treatment systems - Catalytic converters, Diesel oxidation catalyst, Particulate traps, De-NOx catalysts, SCR systems. Low temperature combustion concepts

UNIT V DRIVING CYCLES AND EMISSION STANDARDS 9

Transient dynamometer, Test cells, Driving cycles for emission measurement, chassis dynamometer, CVS system, National and International emission standards.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to

1. Understand about atmospheric pollution from engines and its impact on human health and environment.
2. Understand the formation of emissions in both SI and CI engines.
3. Understand the various measurement techniques used globally for the measurement of automotive and stationary engine out emissions.
4. Learn the various control methods/techniques used in IC engine to control the engine out emissions
5. Learn the transient and steady state driving cycles performed on automotive and stationary engines and emission standards that are followed in the national and international level.

REFERENCES:

1. Ganesan V., “Internal Combustion Engines”, V Edition, Tata McGraw Hill, 2012.
2. John. B. Heywood, “Internal Combustion engine fundamentals” McGraw – Hill, 1988.
3. Crouse William, Automotive Emission Control, Gregg Division /McGraw-Hill,1980
4. Ernest, S., Starkman, Combustion Generated Air Pollutions, Plenum Press, 1980.
5. George Springer and Donald J Patterson, Engine emissions, Pollutant Formation and Measurement, Plenum press, 2013
6. Obert, E.F., Internal Combustion Engines and Air Pollution, Intext Educational Publishers, Third Edition, 1973.
7. Pundir B. P., “IC Engines Combustion and Emission” Narosa publishing house, 2010.

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	1	1	-	1	1	3
2	1	-	-	1	1	2
3	1	-	-	-	2	-
4	1	-	-	1	2	1
5	1	-	-	1	2	-
Avg.	1	0.2	-	0.8	1.6	1.2

IC4092 HYBRID AND ELECTRIC VEHICLES L T P C

3 0 0 3

COURSE OBJECTIVES:

- To introduce the concept of hybrid and electric drive trains.
- To elaborate on the types and utilisation of hybrid and electric drive trains
- To expose on different types of AC and DC drives for electric vehicles.
- To understand and utilise different types of energy storage systems
- To introduce concept of energy management strategies and drive sizing

UNIT I INTRODUCTION 9

Basics of vehicle performance, vehicle power source characterization, transmission characteristics, History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

UNIT II HYBRID ELECTRIC DRIVE TRAINS 9

Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

UNIT III CONTROL OF AC & DC DRIVES 9

Introduction to electric components used in hybrid and electric vehicles, Configuration and control - DC Motor drives, Induction Motor drives, Permanent Magnet Motor drive, and Switch Reluctance Motor drives, drive system efficiency.

UNIT IV ENERGY STORAGE 9

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Energy storage and its analysis - Battery based, Fuel Cell based, and Super Capacitor based, Hybridization of different energy storage devices.

UNIT V DRIVE SIZING AND ENERGY MANAGEMENT STRATEGIES 9

Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selection of appropriate energy storage technology, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification and comparison of energy management strategies, implementation issues.

TOTAL : 45 PERIODS

COURSE OUTCOMES :

On successful completion of this course, the students will be able to:

1. Characterise and configure hybrid drivetrains requirement for a vehicle
2. Design and apply appropriate hybrid and electric drive trains in a vehicle
3. Design and install suitable AC and DC drives for electric vehicles.
4. Arrive at a suitable energy storage system for a hybrid / electric vehicle
5. Apply energy management strategies to ensure better economy and efficiency

REFERENCES:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003
3. MehrdadEhsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
4. Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley & Sons, 1998

CO	PO					
	1	2	3	4	5	6
1	-	2	3	-	2	-
2	3	2	3	-	2	2
3	3	2	3	-	2	2
4	2	2	3	-	2	3
5	2	2	3	-	2	3
Avg	2.5	2	3	-	2	2.5

IC4006 COMBUSTION AND REACTION KINETICS IN I.C. ENGINES L T P C
3 0 0 3

COURSE OBJECTIVES:

- To develop the knowledge about combustion kinetics in SI and CI engines.
- To understand the combustion reaction kinetics in SI and CI engines.

UNIT I INTRODUCTION 9

Gaseous, liquid and solid fuels, Application of the first and second laws of thermodynamics to combustion, – Low temperature reactions – Cool Flames – as applied to detonation. High temperature reactions – species concentration and products formation.

UNIT II CHEMICAL KINETICS OF COMBUSTION 9

Elementary reactions, Pre-ignition kinetics, Ignition delay, Nitric Oxide Kinetics, Soot Kinetics, Calculations, – Reaction control effect on Engine performance and emissions.

UNIT III MODELLING 9

Calculation of equilibrium composition. Enthalpy and Energy, Coefficients for reactions and adiabatic flame temperature, Modeling of CO, HC NO reactions in SI and CI Engines – Soot Modeling

UNIT IV GASOLINE ENGINE COMBUSTION 9

Combustion in S.I. Engines, Laminar flame theory, Flame structure, Turbulent premixed flames, Homogeneous Combustion reactions between Gasoline and air – Reaction rate Constants – species determination. Burning rate estimation.

UNIT V DIESEL ENGINE COMBUSTION 9

Combustion in CI Engine, Spray formation, Spray dynamics, Spray models, Introduction to diesel engine combustion, Premixed and diffusion combustion reactions – Lean flame Reactions – Lean flame out reactions - Species determination. Emissions and Combustion, Ignition Delay and Burning rate estimation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course the student will be able to

1. understand the concept of combustion kinetics
2. Modeling of the combustion process of different fuels
3. Modeling advanced combustion process
4. Understand and formulate the kinetics for CI engine combustion
5. Understand and formulate the kinetics for SI engine combustion

CO	PO					
	1	2	3	4	5	6
1	-	-	3	1	-	1
2	2	2	3	2	3	1
3	3	3	3	2	3	1
4	3	3	3	3	2	1
5	3	3	3	1	2	1
Avg	2.7	2.7	3	2	2.5	1

REFERENCES:

1. J.F. Ferguson, Internal Combustion Engines, John Wiley and Sons, 2004.
2. I R.S. Benson & N.D. Whitehouse, Internal Combustion Engines, First edition, Pergamon Press, England 1979.
3. Combustion Engineering, Gary L Bormann, WCB Mc Graw Hill, 1998.
4. John. B. Heywood, "Internal Combustion engine fundamentals" McGraw – Hill, 1988.
5. A.F. Williams, combustion in flames, Oxford Press, Second Edition, 1978.
6. S.P. Sharma, Fuels and Combustion, S.P. Chand and Co., Sixth Edition, 1982.
7. S. W. Benson, The Foundations of Chemical Kinetics, McGraw-Hill, 1960.

EY4092	ENERGY FORECASTING, MODELING AND PROJECT MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To impart knowledge about the present status of energy scenario in India.
2. To predict the energy demand using various forecasting models.
3. To develop an optimization model for the effective utilization of energy sources.
4. To understand and learn the procedure to the write the project proposal.
5. To learn the present status of energy policies in the country.

UNIT- I ENERGY SCENARIO 9

Role of energy in economic development and social transformation: Energy & GDP, GNP and its dynamics – Energy Sources and Overall Energy demand and Availability – Energy Consumption in various sectors and its changing pattern –Status of Nuclear and Renewable Energy: Present Status and future promise.

UNIT- II FORECASTING MODEL 9

Forecasting Techniques – Regression Analysis – Double Moving Average – Double Experimental Smoothing – Triple Exponential Smoothing – ARIMA model- Validation techniques – Qualitative forecasting–Delphi technique-Concept of Neural Net Works.

UNIT- III OPTIMIZATION MODEL 9

Principles of Optimization – Formulation of Objective Function – Constraints – Multi Objective Optimization–Mathematical Optimization Software–Development of Energy Optimization Model-Development of Scenarios– Sensitivity Analysis-Concept of Fuzzy Logic.

UNIT- IV PROJECT MANAGEMENT 9

Project Preparation – Feasibility Study – Detailed Project Report – Project Appraisal – Social-cost benefit Analysis – Project Cost Estimation – Project Risk Analysis – Project Financing – Financial Evaluation.

UNIT- V ENERGY POLICY 9

National & State Level Energy Issues – National & State Energy Policy – Energy Security –National solar mission – state solar energy policy – Framework of Central Electricity Authority(CEA),Central & States Electricity Regulatory Commissions (CERC & ERCs)**-** Costing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Illustrate the energy scenario and appraise energy availability
2. Predict energy demand using various forecasting models.
3. Develop different optimization model for energy planning.
4. Formulate project proposal and financial evaluation.
5. Interpret the national and state energy policies.

REFERENCES:

1. ArmstrongJ.Scott (ed.), Principles of forecasting: a handbook for researchers and practitioners,Norwell, Massachusetts:Kluwer Academic Publishers.2001.
2. Dhandapani Alagiri, Energy Security in India Current Scenario, the ICFAI University Press,2006.
3. Fred Luthans, BrettC. Luthan, KyleW.Luthans, Organisational Behaviour: An Evidence-Based Approach, Information Age Publishing;13edition,2015
4. Spyros G. Makridakis, Steven C.Wheelwright, Rob J.Hyndman, Forecasting:Methods and Applications, 4th Edition,ISBN:978-0-471-53233-0,2003
5. YangX.S.,Introduction to mathematical optimization:From linear programming to Metaheuristics,Cambridge, Int. Science Publishing,2008.

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	1	3	1	1	2	1
2	3	3	2	3	2	2
3	3	2	2	3	3	2
4	2	3	3	3		2
5	1	3	2			2
Avg.	2	2.8	2	2.5	2.33	1.8

TE4073 HYDROGEN AND FUEL CELL TECHNOLOGIES L T P C
3 0 0 3

COURSE OBJECTIVES

- To study in detail on the hydrogen production methodologies, possible applications and various storage options.
- To understand the working principle of a typical fuel cell, its types and to elaborate on its thermodynamics and kinetics.
- To study the cost effectiveness and eco-friendliness of Fuel Cells.

UNIT I HYDROGEN – BASICS AND PRODUCTION TECHNIQUES 9

Hydrogen – physical and chemical properties, salient characteristics. Production of hydrogen – steam reforming – water electrolysis – gasification and woody biomass conversion – biological hydrogen production – photo dissociation – direct thermal or catalytic splitting of water.

UNIT II HYDROGEN STORAGE AND APPLICATIONS 9

Hydrogen storage options – compressed gas – liquid hydrogen – Hydride – chemical Storage – comparisons. Safety and management of hydrogen. Applications of Hydrogen.

UNIT III FUEL CELLS 9

History – principle - working - thermodynamics and kinetics of fuel cell process – performance evaluation of fuel cell – comparison on battery Vs fuel cell.

UNIT IV FUEL CELL – TYPES 9

Types of fuel cells – AFC, PAFC, SOFC, MCFC, DMFC, PEMFC – relative merits and demerits.

UNIT V APPLICATION OF FUEL CELL AND ECONOMICS 9

Fuel cell usage for domestic power systems, large scale power generation, Automobile, Space. Economic and environmental analysis on usage of Hydrogen and Fuel cell. Future trends in fuel cells.

TOTAL: 45 PERIODS

COURSE OUTCOME

After completion of the syllabus student able to :

Know the working of various fuel cells, their relative advantages / disadvantages and hydrogen generation/storage technologies.

REFERENCES

1. Viswanathan B. and Aulice Scibioh.M, Fuel Cells – Principles and Applications, Universities Press, 2006.
2. Rebecca L. and Busby, Hydrogen and Fuel Cells: A Comprehensive Guide, Penn Well Corporation, Oklahoma, 2005.
3. Bent Sorensen (Sørensen), Hydrogen and Fuel Cells: Emerging Technologies and Applications, Elsevier, UK 2005.
4. Kordesch K. and G.Simader, Fuel Cell and Their Applications, Wiley-Vch, Germany 1996.
5. Hart A.B. and G.J.Womack, Fuel Cells: Theory and Application, Prentice Hall, New York Ltd., London 1989.
6. Jeremy Rifkin, The Hydrogen Economy, Penguin Group, USA 2002.
7. Barclay F.J., Fuel Cells, Engines and Hydrogen, Wiley, 2009.

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	3		3	1	1	2
2	3		3	1	1	2
3	2		2	2		1
4	2		2	1		2
5	2		2	1	3	2
Avg.	2.4		2.4	1.2	1.66	1.8

IC4071 BOUNDARY LAYER THEORY AND TURBULENCE L T P C
3 0 0 3

COURSE OBJECTIVES:

1) To introduce the fundamental concepts of boundary layer in real flows.
2) To distinguish between turbulent and laminar boundary layers.
3) To model turbulent flows using various approaches.
4) To analyse various flow parameters using statistical principles.
5) To introduce the types, characteristics of wall shear flows from free shear flows.

UNIT I FUNDAMENTALS OF BOUNDARY LAYER THEORY 9

Boundary Layer Concept, Laminar Boundary Layer on a Flat Plate at zero incidence, Turbulent Boundary Layer on a Flat plate at zero incidence, Fully Developed Turbulent Flow in a pipe, Boundary Layer on an airfoil, Boundary Layer separation.

UNIT II TURBULENT BOUNDARY LAYERS 9

Internal Flows – Couette flow – Two-Layer Structure of the velocity Field – Universal Laws of the wall– Friction law – Fully developed Internal flows – Channel Flow, Couette – Poiseuille flows, Pipe Flow

UNIT III TURBULENCE AND TURBULENCE MODELS 9

Nature of turbulence – Averaging Procedures – Characteristics of Turbulent Flows – Types of Turbulent Flows – Scales of Turbulence, Prandtl's Mixing length, Two-Equation Models, Low – Reynolds Number Models, Large Eddy Simulation

UNIT IV STATISTICAL THEORY OF TURBULENCE 9

Ensemble Average – Isotropic Turbulence and Homogeneous Turbulence – Kinematics of Isotropic Turbulence – Taylor's Hypothesis – Dynamics of Isotropic Turbulence – Grid Turbulence and decay – Turbulence in Stirred Tanks.

UNIT V TURBULENT FLOWS 9

Wall Turbulent shear flows – Structure of wall flow – Turbulence characteristics of Boundary layer – Free Turbulence shear flows – Jets and wakes – Plane and axi-symmetric flows.

TOTAL : 45 PERIODS

COURSE OUTCOMES :

On successful completion of this course, the students will be able to:

1) Analyse flow with the principles of boundary layer theory
2) Distinguish turbulent boundary layer for various types of flows
3) Select and use various turbulence models for the appropriate applications.
4) Apply the statistical theory for averaging various flow parameters.
5) Differentiate the characteristics of wall shear and free shear flows.

CO	PO					
	1	2	3	4	5	6
1	-	-	1	-	2	-
2	2	2	2	1	2	-
3	2	2	2	2	2	-
4	2	2	2	2	2	-
5	2	2	2	2	2	-
Avg	2	2	1.8	1.7	2	-

REFERENCES:

1. Philip G. Hill and Carl R. Peterson, Mechanics and Thermodynamics of Propulsion, Second Edition, Addition – Wesley Publishing Company, New York, 2009.
2. Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H, Gas Turbine Theory, Longman,1989
3. G.C. Oates, "Aerothermodynamics of Aircraft Engine Components", AIAA Education Series, 1985.
4. S. M. Yahya, Fundamentals of Compressible Flow. Third edition, New Age International Pvt Ltd, 2003.
5. George P. Sutton, Oscar Biblarz. Rocket Propulsion Elements, John Wiley & Sons, 8th Edition, 2010.
6. Ramamurthy, Rocket Propulsion, Pan Macmillan (India) Ltd, 2010.
7. W.P.Gill, H.J.Smith& J.E. Ziurys, "Fundamentals of Internal Combustion Engines asapplied to Reciprocating, Gas turbine & Jet Propulsion Power Plants", Oxford & IBH Publishing Co., 1980.

IC4007 ADVANCED COMBUSTION CONCEPTS IN ENGINES L T P C
3 0 0 3

COURSE OBJECTIVES

- To provide fundamental knowledge about HCCI and its background
- To provide insight about Gasoline and Diesel LTC methods
- To impart knowledge on LTC control methods and its significance
- To provide insight about the fuel requirements for LTC and its effect
- To impart knowledge on LTC combustion operation with alternative fuels

UNIT I LOW TEMPERATURE COMBUSTION ENGINE FUNDAMENTALS 9

Introduction, low temperature combustion (LTC) Fundamentals – Background of LTC, Principle, Benefits, Challenges, Need for control.

UNIT II GASOLINE AND DIESEL LTC ENGINES 9

Conventional Gasoline Combustion, Effects of EGR, Techniques to HCCI operation in gasoline engines, Conventional Diesel Combustion, Overview of diesel HCCI engines, Techniques –Early Injection, Multiple injections, Narrow angle direct injection (NADI™) concept, Modulated kinetics (MK)combustion – First and Second generation of MK combustion, emission, performance improvement.

UNIT III LOW TEMPERATURE COMBUSTION CONTROL 9

Control Methods, Combustion timing sensors, HCCI/SI switching, Transition between operating modes (HCCI-SI-HCCI), Fuel effects in HCCI - gasoline, diesel, auto-ignition requirement, combustion phasing, Influence of equivalence ratio, auto-ignition timing, combustion duration, auto-ignition temperature and auto-ignition pressure, Combustion limits, IMEP and indicated efficiency, other approaches to characterizing fuel performance in HCCI engines.

UNIT IV ADVANCED COMBUSTION FUEL REQUIREMENTS 9

Introduction, Background, Diesel fuel HCCI, HCCI fuel ignition quality, Gasoline HCCI, HCCI fuel specification, Fundamental fuel factors.

UNIT V LTC WITH ALTERNATIVE FUELS 9

Natural gas HCCI engines, CNG HCCI engines, methane/n- butane/air mixtures. DME HCCI engine - chemical reaction model, Combustion completeness, Combustion control system, Method of combining DME and other fuels, Unmixed-ness of DME/air mixture

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to

- Understand the fundamentals of HCCI combustion, benefits and challenges
- Learn the methods followed to achieve HCCI in Gasoline and Diesel engines
- Learn the HCCI combustion control methods and its significance
- Understand the fuel requirements for HCCI operation and its role on complete load range operation
- Learn the HCCI operation with alternative fuels and its comparison over conventional fuels

TEXT BOOKS:

1. Hua Zhao “HCCI and CAI Engines for automotive industry” Wood Head Publishing in Mechanical Engineering, 2007.
2. Pundir B.P., Engine Combustion and Emission, 2011, Narosa Publishing House.

REFERENCES:

1. Ganesan, V, Internal Combustion Engines, Tata McGraw Hill Book Co., 2003
2. John B Heywood, “Internal Combustion Engines Fundamentals”, McGraw Hill International Edition, 1988.
3. Pundir B.P. I.C. Engines Combustion and Emission, 2010, Narosa Publishing House.
4. HCCI Diesel Engines - Nptel - https://nptel.ac.in/courses/112104033/34
5. HCCI and CAI Engines – Nptel - https://nptel.ac.in/courses/112104033/33

CO	PO					
	1	2	3	4	5	6
1	-	1	3	--	-	-
2	2	2	3	-	3	3
3	2	2	3	-	3	3
4	3	2	3	2	3	3
5	3	2	3	2	3	3
Avg	2.5	1.8	3	2	3	3

IC4008 MANUFACTURING AND TESTING OF ENGINE COMPONENTS L T P C

3 0 0 3

COURSE OBJECTIVES:

- To provide a comprehensive module on the aspects of materials, manufacture and testing of piston engine assemblies, components, and subsystems.
- To equip the learners with necessary domain inputs such that they can pursue research, consultancy, academics, or other vocation.
- To introduce the students to CNC programming
- To emphasis on the importance of quality management system
- To provide knowledge necessary to perform computer aided engine testing

UNIT I MATERIALS AND PRODUCTION METHODS 9

Selection – types of Materials – Ferrous: Carbon and Low Alloy steels, High Alloy Steels, and Cast Irons – Nonferrous: Aluminium, Magnesium, Titanium, Copper and Nickel alloys - Composites - Production Methods: casting, forging, powder metallurgy - Machining.

UNIT II ENGINE COMPONENTS 9

Cylinder Block, Cylinder Head, Crankcase and Manifolds, Piston Assembly, Connecting Rod, Crankshaft, Camshaft and Valve Train - Testing Methods.

UNIT III ENGINE AUXILIARIES 9

Fuel injectors, radiators, fans, coolant pumps, ignition system, intake and exhaust systems, and catalytic converters.

UNIT IV COMPUTER INTEGRATED MANUFACTURING 9

Integration of CAD, CAM and CIM – Networking - CNC programming for machining of Engine Components.

UNIT V QUALITY ASSURANCE AND TESTING 9

TS 16949, ISO and BIS codes for testing – Instrumentation for engine testing - computer aided engine testing - metrology for manufacture of engine components - engine tribological aspects.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The student will be able to

1. Choose appropriate materials for manufacturing of engine components.
2. Develop the production process for manufacturing engine components and auxiliaries.
3. Choose appropriate test methods and parameters to test the quality of engine components.
4. Develop CNC programs for simple components.
5. Perform computer aided engine testing.

CO	PO					
	1	2	3	4	5	6
1	3	1	2	1	2	2
2	3	1	2	1	3	2
3	1	2	3	1	3	2
4	3	1	2	3	3	1
5	3	3	3	3	2	3
Avg	2.6	1.6	2.6	1.8	2.4	2

REFERENCES:

1. Ammar Grous. Applied Metrology for Manufacturing Engineering, ISTE Ltd. 2011.
2. Bosch Automotive Handbook, (8th Edition), Robert Bosch GmbH, Germany, 2011.
3. Haslehurst.S.E., Manufacturing Technology, ELBS, London, 1990
4. James D. Halderman and Chase D. Mitchell Jr., Automotive Engines: Theory and Servicing, Pearson Education Inc., 2005.
5. Paul E. Mix, Introduction to Non-destructive Testing: A Training Guide, second edition, John Wiley & Sons, Inc., 2005.
6. Richard D. Atkins, An Introduction to Engine Testing and Development, SAE International, USA, 2009.

IC4009 **SPECIALITY ENGINES** **L T P C**

3 0 0 3

COURSE OBJECTIVES:

- The main objective of this course is to introduce the concept and principle of operation of special vehicles such as Bulldozers, Ditchers, Bucket excavators, farm equipments, military vehicles etc. At the end of the course, the students can have a better understanding of the application of the special types of vehicles in the excavation of earth.

UNIT – I INTRODUCTION **10**

The design features of Automotive, Locomotive, Marine, Stationery and Generator-set engines.

UNIT – II S.I. ENGINE SYSTEMS **10**

Spark ignition engine system variants – Stoichiometric, Lean-burn, port injected/direct injected, carburetted, Air assisted fuel injection engines, HEV Engines. Illustrations – Honda CVCC, Toyota Prius, Orbital Engine etc. Rotary piston engines, Dedicated alternative fueled engine systems – CNG, LPG, H2, Alcohols, Stirling cycle.

UNIT – III C.I. ENGINE SYSTEMS **10**

Compression ignition engine system variants – Low, Medium and High speed system characteristics, High pressure fuel injection systems, Homogeneous Charge Compression Ignition systems, Dual and dedicated alternate fueled engine systems, coal and producer gas fueled engine systems, cogeneration system, Total engine systems.

UNIT – IV SPECIAL PURPOSE ENGINE SYSTEM **10**

Engines for special applications – Mining, Defense, Off-highway – Tractor, Bulldozer etc. Submarines, Race car engine systems, Flexible fueled systems.

UNIT – V LIFE CYCLE ANALYSES OF ENGINE SYSTEMS **5**

Life cycle cost.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Design features of engines for different applications
2. Understanding different types of SI and CI engine systems
3. Understand the engines for earth moving and constructional equipments
4. Understand the concepts of high performance engines
5. Analysis of life cycle

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	2	-	1	-	-	2
2	2	2	2	-	2	2
3	2	1	2	-	2	2
4	2	1	2	-	2	2
5	2	2	3	-	2	2
Avg	2	1.5	2	-	2	2

REFERENCES:

1. Bosch Technical Instruction Booklets, Robert Bosch GmbH, Germany, 1985.
2. Diesel Engine Reference Book, Bernard Challen and RodicaBaranescu (Editors) 2nd Edition, R – 183, SAE International, 1999.
3. Introduction to Internal Combustion Engines, Richard Stone, Third Edition, Society of Automotive Engineers, Inc,USA, 1999.
4. Some Unusual Engines, L.J.K. Setright, Mechanical Engineering Publication Ltd., UK, 1975.
5. The Wankel R C Engine, R.F.Ansdale, A.S.Barnes&Co.,USA, 1969.
6. The Warnkel Engine, Design, Development, Application, Jan P.Norbye, Chilton Book Company, USA, 1971.

IC4010 SUPERCHARGING AND TURBOCHARGING L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To gain knowledge in supercharging and scavenging.
2. To study the thermodynamics of turbo charging
3. To introduce the basic concepts of two stroke cycle engines
4. To gain knowledge in the design of ports and exhaust systems
5. To introduce students the future trends in the design of two stroke cycle engines

UNIT I SUPERCHARGING 9

Engine modifications required - Effects on Engine performance – Thermodynamics, Mechanical Supercharging. Types of compressors – Positive displacement blowers – Centrifugal compressors – Performance characteristic curves – Suitability for engine application – Matching of supercharger, compressor and engine.

UNIT II TURBOCHARGING 9

Turbocharging methods - Thermodynamics – Engine exhaust manifolds arrangements. – Waste gate, Variable nozzle turbochargers, Variable Geometry Turbocharging– Multistage turbocharging - Matching of compressor, Turbine and Engine.

UNIT III SCAVENGING OF TWO STROKE ENGINES 9

Features of two stroke cycle engines – Classification of scavenging systems – Charging Processes in two stroke cycle engine – Terminologies – Sankey diagram – Relation between scavenging terms – scavenging modeling – Perfect displacement, Perfect mixing. Mixture control through Reed valve induction

UNIT IV PORTS AND MUFFLER DESIGN 9

Porting – Port flow characteristics-Design considerations – Design of Intake and Exhaust Systems – Tuning- Kadenacy system.

UNIT V EXPERIMENTAL METHODS AND RECENT TRENDS IN TWO STROKE ENGINES 9

Experimental techniques for evaluating scavenging – Firing engine tests – Non firing engine tests – Development in two stroke engines for improving scavenging. Direct injection two stroke concepts.

COURSE OUTCOMES:

1. Recognize and understand reasons for differences among operating characteristics of superchargers
2. Differentiate among different types of turbocharging methods and design turbochargers
3. Exposure to the different terminologies and scavenging systems
4. Design a two stroke cycle engine
5. Develop skills to run engine dynamometer experiments and understand methods of eliminating short circuiting

CO	PO					
	1	2	3	4	5	6
1	-	-	2	-	1	1
2	-	-	3	-	2	2
3	-	-	3	-	1	1
4	2	2	3	-	1	2
5	2	2	3	-	3	2
Avg	2	2	2.8	-	1.6	1.6

REFERENCES:

1. Blair G P, Two stroke Cycle Engines Design and Simulation, SAE Publications, 1997.
2. Heinz Heisler, Advanced Engine Technology, Butterworth Heinmann Publishers, 2002.
3. John B. Heywood, Two Stroke Cycle Engine, SAE Publications, 1999.
4. Schweitzer, P.H., Scavenging of Two Stroke Cycle Diesel Engine, MacMillan Co., 1949.
5. Watson, N. and Janota, M.S., Turbocharging the I.C. Engine, MacMillan Co., 1982.

EY4091 ADVANCED ENERGY STORAGE TECHNOLOGIES

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To understand the various types of energy storage technologies and its applications.
2. To study the various modeling techniques of energy storage systems using TRNSYS.
3. To learn working concepts and types of batteries.
4. To make the students to get understand the concepts of Hydrogen and Biogas storage.
5. To provide the insights on super capacitor, Fly wheel and compressed energy storage system.

UNIT– I INTRODUCTION **9**

Necessity of energy storage–types of energy storage–comparison of energy storage technologies– Applications.

UNIT– II THERMAL STORAGE SYSTEM **9**

Thermal storage–Types–Modelling of thermal storage units–Simple water and rock bed storage system–pressurized water storage system–Modelling of phase change storage system –Simple units, packed bed storage units – Modelling using porous medium approach, Use of TRNSYS.

UNIT–III ELECTRICAL ENERGY STORAGE 9

Fundamental concept of batteries–measuring of battery performance, charging and discharging of a battery, storage density, energy density, and safety issues. Types of batteries – Lead Acid, Nickel–Cadmium, Zinc Manganese di oxide and modern batteries for example(i)zinc-Air(ii)Nickel Hydride,(iii)Lithium Battery.

UNIT– IV HYDROGEN AND BIOGAS STORAGE 9

Hydrogen storage options–compressed gas–liquid hydrogen–Metal Hydrides, chemical Storage, Biogas storage-comparisons. Safety and management of hydrogen and Biogas storage - Applications.

UNIT– V ALTERNATE ENERGY STORAGE TECHNOLOGIES 9

Flywheel, Super capacitors, Principles & Methods–Applications, Compressed air Energy storage, Concept of Hybrid Storage – Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Identify the energy storage technologies for suitable applications.
2. Analyze the energy storage systems using TRNSYS.
3. Summarise the concepts and types of batteries.
4. Examine the principle of operation of Hydrogen and Biogas storage systems.
5. Explain the working of super capacitor, Flywheel and compressed energy storage systems

REFERENCES:

1. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2010.
2. Viswanathan, Fuel cell principle and applications university press,2006.
3. Luisa F.Cabeza, Advances in Thermal Energy Storage Sy stems: Methods and Applications, Elsevier Wood head Publishing, 2015
4. Robert Huggins, Energy Storage: Fundamentals, Materials and Applications, 2nd edition, Springer,2015.
5. Ru-shiliu, Leizhang, Xueliang sun, Electrochemical technologies for energy storage and conversion,,Wileypublications,2012.
6. National Energy Technology Laboratory, U.S. Department of Energy, Fuel Cell Handbook (Seventh Edition).

CO	PO					
	1	2	3	4	5	6
1	2		1	2		
2	2		3	3		
3	2		1	2		
4	2		1	2		
5	2		1	2		
Avg.	2		1.4	2.2		

IC4011 ELECTRICAL DRIVES AND CONTROLS L T P C
3 0 0 3

COURSEOBJECTIVES

1. To impart the knowledge on the principle of conventional motor drives, various starting and speed control methods of motors.
2. To understand the concepts of various losses and harmonics effects in motors.
3. To study the Power Electronics components and controllers.
4. To provide insights of Superconductivity theory and super conducting magnetic energy storage.
5. To understand the concept of Solid State motor controllers and their applications

UNIT I CONVENTIONAL MOTOR DRIVES 9

Characteristics of DC and AC motor for various applications - starting and speed control - methods of breaking.

UNIT II PHYSICAL PHENOMENA IN ELECTRICAL MACHINES 9

Various losses in motors-Saturation and Eddy current effects - MMF harmonics and their influence of leakage-stray losses - vibration and noise.

UNIT III SOLID STATE POWER CONTROLLERS 9

Power devices: Triggering Circuits, Rectifiers – Single Phase and Three Phase with R, RL and Freewheeling Diode, Choppers - Type-A, Type-B, Type C and Type D, Inverters –Single-phase and Three Phase with R, RL and Freewheeling Diode, AC Voltage Controllers

UNIT IV SUPERCONDUCTIVITY 9

Principle of Super conductivity, super conducting generators-motors and magnets - Super conducting magnetic energy storage (SMES).

UNIT V SOLID STATE MOTOR CONTROLLERS 9

Single and Three Phase fed DC motor drives - AC motor drives - Voltage Control - Rotor resistance control - Frequency control - Slip Power Recovery scheme

TOTAL: 45 PERIODS

OUTCOMES

1. Diagnose the operations of conventional motor drives, various starting and speed control methods of motors.
2. Analyze the different losses and harmonic effects in motors.
3. Recognize the Power electronics components and design the controllers.
4. Apply the Superconductivity theory and analyze the super conducting magnetic energy storage.
5. Analyse the concept of Solid State motor controllers and their applications

CO	PO					
	1	2	3	4	5	6
1	-	1	2	-	1	-
2	2	1	2	-	1	-
3	2	1	3	-	1	-
4	3	2	3	2	2	3
5	3	2	3	2	3	2
Avg	2.5	2.4	2.6	2	1.6	2.5

REFERENCES
1. Subrahmanyam, Electric Drives : Concepts & Applications 2/E, Tata McGraw Hill Education,2011
2. Robert A. Huggins, Energy Storage , Springer(2010)
3. Rene Husson, Modelling and Control of Electrical machines, Elsevier Science Ltd, 2009
4. D.Singh, K.B.Khanchandani, Power Electronics, Tata McGraw Hill Education Ltd, s2006
5. Austin Hughes, Electric Motor & Drives, Newnes, 2006.

AUDIT COURSES

AX4091 ENGLISH FOR RESEARCH PAPER WRITING **L T P C**
2 0 0 0

COURSE OBJECTIVES
- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING **6**
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS **6**
Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS **6**
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS **6**
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS **6**
Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission

TOTAL: 30 PERIODS

COURSE OUTCOMES
CO1 –Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section

CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

REFERENCES

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

AX4092 DISASTER MANAGEMENT L T P C
2 0 0 0

COURSE OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION 6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA 6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT 6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

COURSE OUTCOMES

CO1: Ability to summarize basics of disaster
CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCES

1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company,2007.
3. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi,2001.

AX4093 CONSTITUTION OF INDIA L T P C
2 0 0 0

OBJECTIVES

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila

Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization
- of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING

- The Constitution of India,1950(Bare Act),Government Publication.
- Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
- M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
- D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

AX4094 **நற்றமிழ் இலக்கியம்** **L T P C**
2 0 0 0

UNIT I சங்க இலக்கியம் **6**

1. தமிழின் துவக்க நூல் தொல்காப்பியம்
   – எழுத்து, சொல், பொருள்
2. அகநானூறு (82)
   - இயற்கை இன்னிசை அரங்கம்
3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி
4. புறநானூறு (95,195)
   - போரை நிறுத்திய ஔவையார்

UNIT II அறநெறித் தமிழ் **6**

1. அறநெறி வகுத்த திருவள்ளுவர்
   அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புரவறிதல் அறிதல், ஈகை, புகழ்
2. பிற அறநூல்கள் - இலக்கிய மருந்து

– ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை (தூய்மையை வலியுறுத்தும் நூல்)

UNIT III இரட்டைக் காப்பியங்கள் 6

1. கண்ணகியின் புரட்சி
   - சிலப்பதிகார வழக்குரை காதை
2. சமூகசேவை இலக்கியம் மணிமேகலை
   - சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை

UNIT IV அருள்நெறித் தமிழ் 6

1. சிறுபாணாற்றுப்படை
   - பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்
2. நற்றிணை
   - அன்னைக்குரிய புன்னை சிறப்பு
3. திருமந்திரம் (617, 618)
   - இயமம் நியமம் விதிகள்
4. தர்மச்சாலையை நிறுவிய வள்ளலார்
5. புறநானூறு
   - சிறுவனே வள்ளலானான்
6. அகநானூறு (4) - வண்டு
   நற்றிணை (11) - நண்டு
   கலித்தொகை (11) - யானை, புறா
   ஐந்திணை 50 (27) - மான்
   ஆகியவை பற்றிய செய்திகள்

UNIT V நவீன தமிழ் இலக்கியம் 6

1. உரைநடைத் தமிழ்,
   - தமிழின் முதல் புதினம்,
   - தமிழின் முதல் சிறுகதை,
   - கட்டுரை இலக்கியம்,
   - பயண இலக்கியம்,
   - நாடகம்,
2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,
4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
5. அறிவியல் தமிழ்,

6. இணையத்தில் தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

TOTAL: 30 PERIODS

<u>தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்</u>

1. தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University)
   - www.tamilvu.org
   2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia)
   -https://ta.wikipedia.org
3. தர்மபுர ஆதீன வெளியீடு
4. வாழ்வியல் களஞ்சியம்
   - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக் களஞ்சியம்
   - தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)
6. அறிவியல் களஞ்சியம்
   - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்

OCE431 INTEGRATED WATER RESOURCES MANAGEMENT L T P C
3 0 0 3

OBJECTIVE

- Students will be introduced to the concepts and principles of IWRM, which is inclusive of the economics, public-private partnership, water & health, water & food security and legal & regulatory settings.

UNIT I CONTEXT FOR IWRM 9

Water as a global issue: key challenges – Definition of IWRM within the broader context of development – Key elements of IWRM - Principles – Paradigm shift in water management - Complexity of the IWRM process – UN World Water Assessment - SDGs.

UNIT II WATER ECONOMICS 9

Economic view of water issues: economic characteristics of water good and services – Non-market monetary valuation methods – Water economic instruments – Private sector involvement in water resources management: PPP objectives, PPP models, PPP processes, PPP experiences through case studies.

UNIT III LEGAL AND REGULATORY SETTINGS 9

Basic notion of law and governance: principles of international and national law in the area of water management - Understanding UN law on non-navigable uses of international water courses – International law for groundwater management – World Water Forums – Global Water Partnerships - Development of IWRM in line with legal and regulatory framework.

UNIT IV WATER AND HEALTH WITHIN THE IWRM CONTEXT 9

Links between water and health: options to include water management interventions for health – Health protection and promotion in the context of IWRM – Global burden of Diseases - Health impact assessment of water resources development projects – Case studies.

UNIT V AGRICULTURE IN THE CONCEPT OF IWRM 9

Water for food production: 'blue' versus 'green' water debate – Water foot print - Virtual water trade for achieving global water and food security –- Irrigation efficiencies, irrigation methods - current water pricing policy– scope to relook pricing.

TOTAL: 45 PERIODS

OUTCOMES

- On completion of the course, the student is expected to be able to

CO1	Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management.
CO2	Select the best economic option among the alternatives; illustrate the pros and cons of PPP through case studies.
CO3	Apply law and governance in the context of IWRM.
CO4	Discuss the linkages between water-health; develop a HIA framework.
CO5	Analyse how the virtual water concept pave way to alternate policy options.

REFERENCES:

1. Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.
2. Mollinga .P. etal " Integrated Water Resources Management", Water in South Asia Volume I, Sage Publications, 2006.
3. Technical Advisory Committee, Integrated Water Resources management, Technical Advisory Committee Background Paper No: 4. Global water partnership, Stockholm, Sweden. 2002.
4. Technical Advisory Committee, Dublin principles for water as reflected in comparative assessment of institutional and legal arrangements for Integrated Water Resources Management, Technical Advisory Committee Background paper No: 3. Global water partnership, Stockholm, Sweden. 1999.
5. Technical Advisory Committee, Effective Water Governance". Technical Advisory Committee Background paper No: 7. Global water partnership, Stockholm, Sweden, 2003.

CO – PO Mapping - INTEGRATED WATER RESOURCES MANAGEMENT

POs/PSOs		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	3	2	2	2	2	2
PO2	Problem analysis	1	3	2	2	2	2
PO3	Design / development of solutions		2	2	2	2	2
PO4	Investigation	1	2			1	1
PO5	Modern Tool Usage	1	1	2	1	1	1
PO6	Individual and Team work		2	2			2
PO7	Communication		2	2			2
PO8	Engineer and Society	2	2	3	2	3	3
PO9	Ethics		2	3	2	2	2
PO10	Environment and Sustainability	3	3	3	3	3	3
PO11	Project Management and Finance	1	1	1		1	1
PO12	Life Long Learning		2	2	2	2	2
PSO1	Knowledge of field research methodology, gender, legal and environmental aspects in the context of integrated water resources management	3	2	2	2	2	2
PSO2	Formulate, analyze and comprehend the differences in social and environmental variability in South Indian context with their peers and strive to work towards sustainability	2	2	2	2	2	2
PSO3	Produce and publish professional reports, peer-reviewed journal, on contemporary and state of the art research in integrated water resources management	2	2	2	2	2	2

OCE432 **WATER, SANITATION AND HEALTH** **L T P C**
3 0 0 3

OBJECTIVES:

- Understand the accelerating health impacts due to the present managerial aspects and initiatives in water and sanitation and health sectors in the developing scenario

UNIT I FUNDAMENTALS WASH 9

Meanings and Definition: Safe Water- Health, Nexus: Water- Sanitation - Health and Hygiene – Equity issues-Water security - Food Security. Sanitation And Hygiene (WASH) and Integrated Water Resources Management (IWRM) - Need and Importance of WASH

UNIT II MANAGERIAL IMPLICATIONS AND IMPACT 9

Third World Scenario – Poor and Multidimensional Deprivation--Health Burden in Developing Scenario -Factors contribute to water, sanitation and hygiene related diseases-Social: Social Stratification and Literacy Demography: Population and Migration- Fertility - Mortality-Environment: Water Borne-Water Washed and Water Based Diseases - Economic: Wage - Water and Health Budgeting -Psychological: Non-compliance - Disease Relapse - Political: Political Will.

UNIT III CHALLENGES IN MANAGEMENT AND DEVELOPMENT 9

Common Challenges in WASH - Bureaucracy and Users- Water Utilities -Sectoral Allocation:-Infrastructure- Service Delivery: Health services: Macro and Micro- level: Community and Gender Issues- Equity Issues - Paradigm Shift: Democratization of Reforms and Initiatives.

UNIT IV GOVERNANCE 9

Public health -Community Health Assessment and Improvement Planning (CHA/CHIP)-Infrastructure and Investments on Water, (WASH) - Cost Benefit Analysis – Institutional Intervention-Public Private Partnership - Policy Directives - Social Insurance -Political Will vs Participatory Governance -

UNIT V INITIATIVES 9

Management vs Development -Accelerating Development- Development Indicators -Inclusive Development-Global and Local- Millennium Development Goal (MDG) and Targets - Five Year Plans - Implementation - Capacity Building - Case studies on WASH.

TOTAL: 45 PERIODS

OUTCOMES:

CO1	Capture to fundamental concepts and terms which are to be applied and understood all through the study.
CO2	Comprehend the various factors affecting water sanitation and health through the lens of third world scenario.
CO3	Critically analyse and articulate the underlying common challenges in water, sanitation and health.
CO4	Acquire knowledge on the attributes of governance and its say on water sanitation and health.
CO5	Gain an overarching insight in to the aspects of sustainable resource management in the absence of a clear level playing field in the developmental aspects.

REFERENCES

1. Bonitha R., Beaglehole R.,Kjellstorm, 2006, "Basic Epidemiology", 2nd Edition, World Health Organization.
2. Van Note Chism, N. and Bickford, D. J. (2002), Improving the environment for learning: An expanded agenda. New Directions for Teaching and Learning, 2002: 91–98. doi: 10.1002/tl.83Improving the Environment for learning: An Expanded Agenda
3. National Research Council. *Global Issues in Water, Sanitation, and Health: Workshop Summary***.** Washington, DC: The National Academies Press, 2009.
4. Sen, Amartya 1997. On Economic Inequality. Enlarged edition, with annex by JamesFoster and Amartya Sen, Oxford: Claredon Press, 1997.
5. Intersectoral Water Allocation Planning and Management, 2000, World Bank Publishers www. Amazon.com
6. Third World Network.org (www.twn.org).

CO PO MAPPING : WATER, SANITATION AND HEALTH

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences		1	1	M	1	1
PO2	Problem analysis		2	2	2	2	2
PO3	Design / development of solutions			2	1	2	2
PO4	Investigation		2	3	3	3	3
PO5	Modern Tool Usage				1		1
PO6	Individual and Team work		2	2	1	2	2
PO7	Communication				2	2	2
PO8	Engineer and Society		3	3	3	3	3
PO9	Ethics			1	2	2	2
PO10	Environment and Sustainability		3			3	3
PO11	Project Management and Finance					1	1
PO12	Life Long Learning	2	3	2	3	3	3
PSO1	Explain the concepts of water management, field research methodology, gender, legal and environmental aspects in the context of integrated water resources management		3	3	3	3	3
PSO2	Formulate, analyse and comprehend the differences in social and economic variability in South Asian context with their peers and strive to work towards sustainability.		3	2	3	3	3
PSO3	Produce and publish professional reports, peer reviewed journal on contemporary and state of art research in water resources Engineering.		3	3	3	2	3

OCE433 PRINCIPLES OF SUSTAINABLE DEVELOPMENT L T P C
3 0 0 3

OBJECTIVES:

- To impart knowledge on environmental, social and economic dimensions of sustainability and the principles evolved through landmark events so as to develop an action mindset for sustainable development.

UNIT I SUSTAINABILITY AND DEVELOPMENT CHALLEGES 9

Definition of sustainability – environmental, economical and social dimensions of sustainability - sustainable development models – strong and weak sustainability – defining development-millennium development goals – mindsets for sustainability: earthly, analytical, precautionary, action and collaborative– syndromes of global change: utilisation syndromes, development syndromes, and sink syndromes – core problems and cross cutting Issues of the 21 century - global, regional and local environmental issues – social insecurity - resource degradation –climate change – desertification.

UNIT II PRINCIPLES AND FRAME WORK 9

History and emergence of the concept of sustainable development - our common future - Stockholm to Rio plus 20– Rio Principles of sustainable development – Agenda 21 natural step-peoples earth charter – business charter for sustainable development –UN Global Compact - Role of civil society, business and government – United Nations' 2030 Agenda for sustainable development – 17 sustainable development goals and targets, indicators and intervention areas

UNIT III SUSTAINABLE DEVELOPMENT AND WELLBEING 9

The Unjust World and inequities - Quality of Life - Poverty, Population and Pollution - Combating Poverty - - Demographic dynamics of sustainability - Strategies to end Rural and Urban Poverty and Hunger – Sustainable Livelihood Framework- Health, Education and Empowerment of Women, Children, Youth, Indigenous People, Non-Governmental Organizations, Local Authorities and Industry for Prevention, Precaution , Preservation and Public participation.

UNIT IV SUSTAINABLE SOCIO-ECONOMIC SYSTEMS 10

Sustainable Development Goals and Linkage to Sustainable Consumption and Production – Investing in Natural Capital- Agriculture, Forests, Fisheries - Food security and nutrition and sustainable agriculture- Water and sanitation - Biodiversity conservation and Ecosystem integrity – Ecotourism - Sustainable Cities – Sustainable Habitats- Green Buildings - Sustainable Transportation –– Sustainable Mining - Sustainable Energy– Climate Change –Mitigation and Adaptation - Safeguarding Marine Resources - Financial Resources and Mechanisms

UNIT V ASSESSING PROGRESS AND WAY FORWARD 8

Nature of sustainable development strategies and current practice**-** Sustainability in global, regional and national context –Approaches to measuring and analysing sustainability– limitations of GDP- Ecological Footprint- Human Development Index- Human Development Report – National initiatives for Sustainable Development - Hurdles to Sustainability - Science and Technology for sustainable development –Performance indicators of sustainability and Assessment mechanism –

Inclusive Green Growth and Green Economy – National Sustainable Development Strategy Planning and National Status of Sustainable Development Goals

TOTAL: 45 PERIODS

OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1	Explain and evaluate current challenges to sustainability, including modern world social, environmental, and economic structures and crises.
CO2	Identify and critically analyze the social environmental, and economic dimensions of sustainability in terms of UN Sustainable development goals
CO3	Develop a fair understanding of the social, economic and ecological linkage of Human well being, production and consumption
CO4	Evaluate sustainability issues and solutions using a holistic approach that focuses on connections between complex human and natural systems.
CO5	Integrate knowledge from multiple sources and perspectives to understand environmental limits governing human societies and economies and social justice dimensions of sustainability.

REFERENCES:

1. Tom Theis and Jonathan Tomkin, Sustainability: A Comprehensive Foundation, Rice University, Houston, Texas, 2012
2. A guide to SDG interactions:from science to implementation, International Council for Science, Paris,2017
3. Karel Mulder, Sustainable Development for Engineers - A Handbook and Resource Guide, Rouledge Taylor and Francis, 2017.
4. The New Global Frontier - Urbanization, Poverty and Environmentin the 21st Century - *George Martine,Gordon McGranahan,Mark Montgomery and Rogelio Fernández-Castilla,* IIED and UNFPA, Earthscan, UK, 2008
5. Nolberto Munier, Introduction to Sustainability: Road to a Better Future, Springer, 2006
6. Barry Dalal Clayton and Stephen Bass, Sustainable Development Strategies- a resource book", Earthscan Publications Ltd, London, 2002.

CO – PO Mapping –Principles of Sustainable Development

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences						
PO2	Problem analysis	3	3				3
PO3	Design / development of solutions				3	3	3
PO4	Investigation		2	2	2	2	2
PO5	Modern Tool Usage						
PO6	Individual and Team work		2	2			2
PO7	Communication					1	1
PO8	Engineer and Society	3			3		3
PO9	Ethics				2	2	2
PO10	Environment and Sustainability	3	3	3	3	3	3
PO11	Project Management and Finance						
PO12	Life Long Learning					1	1
PSO1	Knowledge of Environmental Management discipline	3	3	3	3		3

PSO2	Environmental Performance Evaluation and coordination						
PSO3	Conceptualization of Environmental Management Systems						

OCE434 ENVIRONMENTAL IMPACT ASSESSMENT L T P C
3 0 0 3

OBJECTIVES:

- To make the students to understand environmental clearance, its legal requirements and to provide knowledge on overall methodology of EIA, prediction tools and models, environmental management plan and case studies.

UNIT I INTRODUCTION 9

Historical development of Environmental Impact Assessment (EIA). Environmental Clearance- EIA in project cycle. legal and regulatory aspects in India – types and limitations of EIA –EIA process-screening – scoping - terms of reference in EIA- setting – analysis – mitigation. Cross sectoral issues –public hearing in EIA- EIA consultant accreditation.

UNIT II IMPACT INDENTIFICATION AND PREDICTION 10

Matrices – networks – checklists – cost benefit analysis – analysis of alternatives – expert systems in EIA. prediction tools for EIA – mathematical modeling for impact prediction – assessment of impacts – air – water – soil – noise – biological — cumulative impact assessment

UNIT III SOCIO-ECONOMIC IMPACT ASSESSMENT 8

Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. factors and methodologies- individual and family level impacts. communities in transition-rehabilitation

UNIT IV EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN 9

Environmental management plan - preparation, implementation and review – mitigation and rehabilitation plans – policy and guidelines for planning and monitoring programmes – post project audit – documentation of EIA findings – ethical and quality aspects of environmental impact assessment

UNIT V CASE STUDIES 9

Mining, power plants, cement plants, highways, petroleum refining industry, storage & handling of hazardous chemicals, common hazardous waste facilities, CETPs, CMSWMF, building and construction projects

TOTAL: 45 PERIODS

OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1	Understand need for environmental clearance, its legal procedure, need of EIA, its types, stakeholders and their roles
CO2	Understand various impact identification methodologies, prediction techniques and model of impacts on various environments
CO3	Understand relationship between social impacts and change in community due

	to development activities and rehabilitation methods
CO4	Document the EIA findings and prepare environmental management and monitoring plan
CO5	Identify, predict and assess impacts of similar projects based on case studies

REFERENCES:

1. EIA Notification 2006 including recent amendments, by Ministry of Environment, Forest and Climate Change, Government of India
2. Sectoral Guidelines under EIA Notification by Ministry of Environment, Forest and Climate Change, Government of India
3. Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York. 1996
4. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey. 2003
5. Lee N. and George C. 2000. Environmental Assessment in Developing and Transitional Countries. Chichester: Willey
6. World Bank –Source book on EIA ,1999
7. Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification Assessment and Control, 4th Edition, Butterworth Heineman, 2012.

CO – PO Mapping- ENVIRONMENTAL IMPACT ASSESSMENT

PO/PSO		Course Outcome					Overall Correlation of COs to Pos
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences		3			3	3
PO2	Problem analysis		2	2			2
PO3	Design / development of solutions		3	3	3		3
PO4	Investigation		2	2		2	2
PO5	Modern Tool Usage		2	2	3		2
PO6	Individual and Team work		2	2	2		2
PO7	Communication				1		1
PO8	Engineer and Society	2			2		2
PO9	Ethics	3	3	3	2	2	3
PO10	Environment and Sustainability	3			2		2
PO11	Project Management and Finance				1		L
PO12	Life Long Learning		1	1			L
PSO1	Knowledge of Environmental Engineering discipline	2					2
PSO2	Environmental Performance Evaluation and coordination		2	2	2		2
PSO3	Conceptualization of Environmental Engineering Systems		2		2		2

OIC431 BLOCKCHAIN TECHNOLOGIES L T P C
3 0 0 3

COURSE OBJECTIVES:

- This course is intended to study the basics of Blockchain technology.
- During this course the learner will explore various aspects of Blockchain technology like application in various domains.
- By implementing, learners will have idea about private and public Blockchain, and smart contract.

UNIT I INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN 9

Introduction to Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain.

UNIT II BITCOIN AND CRYPTOCURRENCY 9

Introduction to Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency.

UNIT III INTRODUCTION TO ETHEREUM 9

Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, , Transactions, Receiving Ethers, Smart Contracts.

UNIT-IV INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING 10

Introduction to Hyperledger, Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types.

UNIT V BLOCKCHAIN APPLICATIONS 8

Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After the completion of this course, student will be able to

CO1: Understand and explore the working of Blockchain technology
CO2: Analyze the working of Smart Contracts
CO3: Understand and analyze the working of Hyperledger
CO4: Apply the learning of solidity to build de-centralized apps on Ethereum
CO5: Develop applications on Blockchain

REFERENCES:

1. Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained”, Second Edition, Packt Publishing, 2018.
2. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, “Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction” Princeton University Press, 2016
3. Antonopoulos, Mastering Bitcoin, O’Reilly Publishing, 2014. .
4. Antonopoulos and G. Wood, “Mastering Ethereum: Building Smart Contracts and Dapps”, O’Reilly Publishing, 2018.
5. D. Drescher, Blockchain Basics. Apress, 2017.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	1	3	2	2	3
2	2	1	2	3	2	2
3	2	1	3	1	2	1
4	2	1	2	3	2	2
5						
Avg	2.00	1.00	2.50	2.25	2.00	2.00

OIC432 DEEP LEARNING L T P C
3 0 0 3

COURSE OBJECTIVES:

- Develop and Train Deep Neural Networks.
- Develop a CNN, R-CNN, Fast R-CNN, Faster-R-CNN, Mask-RCNN for detection and recognition
- Build and train RNNs, work with NLP and Word Embeddings
- The internal structure of LSTM and GRU and the differences between them
- The Auto Encoders for Image Processing

UNIT I DEEP LEARNING CONCEPTS 6

Fundamentals about Deep Learning. Perception Learning Algorithms. Probabilistic modelling. Early Neural Networks. How Deep Learning different from Machine Learning. Scalars. Vectors. Matrixes, Higher Dimensional Tensors. Manipulating Tensors. Vector Data. Time Series Data. Image Data. Video Data.

UNIT II NEURAL NETWORKS 9

About Neural Network. Building Blocks of Neural Network. Optimizers. Activation Functions. Loss Functions. Data Pre-processing for neural networks, Feature Engineering. Overfitting and Underfitting. Hyperparameters.

UNIT III CONVOLUTIONAL NEURAL NETWORK 10

About CNN. Linear Time Invariant. Image Processing Filtering. Building a convolutional neural network. Input Layers, Convolution Layers. Pooling Layers. Dense Layers. Backpropagation Through the Convolutional Layer. Filters and Feature Maps. Backpropagation Through the Pooling Layers. Dropout Layers and Regularization. Batch Normalization. Various Activation Functions. Various Optimizers. LeNet, AlexNet, VGG16, ResNet. Transfer Learning with Image Data. Transfer Learning using Inception Oxford VGG Model, Google Inception Model, Microsoft ResNet Model. R-CNN, Fast R-CNN, Faster R-CNN, Mask-RCNN, YOLO

UNIT VI NATURAL LANGUAGE PROCESSING USING RNN 10

About NLP & its Toolkits. Language Modeling . Vector Space Model (VSM). Continuous Bag of Words (CBOW). Skip-Gram Model for Word Embedding. Part of Speech (PoS) Global Co-occurrence Statistics–based Word Vectors. Transfer Learning. Word2Vec. Global Vectors for Word Representation GloVe. Backpropagation Through Time. Bidirectional RNNs (BRNN) . Long Short Term Memory (LSTM). Bi-directional LSTM. Sequence-to-Sequence Models (Seq2Seq). Gated recurrent unit GRU.

UNIT V DEEP REINFORCEMENT & UNSUPERVISED LEARNING 10

About Deep Reinforcement Learning. Q-Learning. Deep Q-Network (DQN). Policy Gradient Methods. Actor-Critic Algorithm. About Autoencoding. Convolutional Auto Encoding. Variational Auto Encoding. Generative Adversarial Networks. Autoencoders for Feature Extraction. Auto Encoders for Classification. Denoising Autoencoders. Sparse Autoencoders

COURSE OUTCOMES:

CO1: Feature Extraction from Image and Video Data
CO2: Implement Image Segmentation and Instance Segmentation in Images
CO3: Implement image recognition and image classification using a pretrained network (Transfer Learning)
CO4: Traffic Information analysis using Twitter Data
CO5: Autoencoder for Classification & Feature Extraction

TOTAL : 45 PERIODS

REFERENCES

1. Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc.2017
2. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018
3. Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020
4. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017
5. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress,2017

OBA431 SUSTAINABLE MANAGEMENT LT P C
3 0 0 3

COURSE OBJECTIVES:

- To provide students with fundamental knowledge of the notion of corporate sustainability.
- To determine how organizations impacts on the environment and socio-technical systems, the relationship between social and environmental performance and competitiveness, the approaches and methods.

UNIT I MANAGEMENT OF SUSTAINABILITY 9

Management of sustainability -rationale and political trends: An introduction to sustainability management, International and European policies on sustainable development, theoretical pillars in sustainability management studies.

UNIT II CORPORATE SUSTAINABILITY AND RESPONSIBILITY 9

Corporate sustainability parameter, corporate sustainability institutional framework, integration of sustainability into strategic planning and regular business practices, fundamentals of stakeholder engagement.

UNIT III SUSTAINABILITY MANAGEMENT: STRATEGIES AND APPROACHES 9

Corporate sustainability management and competitiveness: Sustainability-oriented corporate strategies, markets and competitiveness, Green Management between theory and practice, Sustainable Consumption and Green Marketing strategies, Environmental regulation and strategic postures; Green Management approaches and tools; Green engineering: clean technologies and innovation processes; Sustainable Supply Chain Management and Procurement.

UNIT IV SUSTAINABILITY AND INNOVATION 9

Socio-technical transitions and sustainability, Sustainable entrepreneurship, Sustainable pioneers in green market niches, Smart communities and smart specializations.

UNIT V SUSTAINABLE MANAGEMENT OF RESOURCES, COMMODITIES AND COMMONS 9

Energy management, Water management, Waste management, Wild Life Conservation, Emerging trends in sustainable management, Case Studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: An understanding of sustainability management as an approach to aid in evaluating and minimizing environmental impacts while achieving the expected social impact.
CO2: An understanding of corporate sustainability and responsible Business Practices
CO3: Knowledge and skills to understand, to measure and interpret sustainabilityperformances.
CO4: Knowledge of innovative practices in sustainable business and community management
CO5: Deep understanding of sustainable management of resources and commodities

REFERENCES:

1. Daddi, T., Iraldo, F., Testa, Environmental Certification for Organizations and Products: Management, 2015
2. Christian N. Madu, Handbook of Sustainability Management 2012
3. Petra Molthan-Hill, The Business Student's Guide to Sustainable Management: Principles and Practice, 2014
4. Margaret Robertson, Sustainability Principles and Practice, 2014
5. Peter Rogers, An Introduction to Sustainable Development, 2006

MAPPING OF POs AND COs:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	1	2	2
CO2	3	2	2	2	1	2
CO3	3	3	1	2	2	3
CO4	3	3	2	1	1	2
CO5	3	3	2	1	2	2

OBA432 MICRO AND SMALL BUSINESS MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVES

- To familiarize students with the theory and practice of small business management.
- To learn the legal issues faced by small business and how they impact operations.

UNIT I INTRODUCTION TO SMALL BUSINESS 9

Creation, Innovation, entrepreneurship and small business - Defining Small Business –Role of Owner – Manager – government policy towards small business sector –elements of

entrepreneurship –evolution of entrepreneurship –Types of Entrepreneurship – social, civic, corporate - Business life cycle - barriers and triggers to new venture creation – process to assist start ups – small business and family business.

UNIT II SCREENING THE BUSINESS OPPORTUNITY AND FORMULATING THE BUSINESS PLAN 9

Concepts of opportunity recognition; Key factors leading to new venture failure; New venture screening process; Applying new venture screening process to the early stage small firm Role planning in small business – importance of strategy formulation – management skills for small business creation and development.

UNIT III BUILDING THE RIGHT TEAM AND MARKETING STRATEGY 9

Management and Leadership – employee assessments – Tuckman's stages of group development - The entrepreneurial process model - Delegation and team building - Comparison of HR management in small and large firms - Importance of coaching and how to apply a coaching model.

Marketing within the small business - success strategies for small business marketing - customer delight and business generating systems, - market research, - assessing market performance-sales management and strategy - the marketing mix and marketing strategy.

UNIT IV FINANCING SMALL BUSINESS 9

Main sources of entrepreneurial capital; Nature of 'bootstrap' financing - Difference between cash and profit - Nature of bank financing and equity financing - Funding-equity gap for small firms. Importance of working capital cycle - Calculation of break-even point - Power of gross profit margin- Pricing for profit - Credit policy issues and relating these to cash flow management and profitability.

UNIT V VALUING SMALL BUSINESS AND CRISIS MANAGEMENT 9

Causes of small business failure - Danger signals of impending trouble - Characteristics of poorly performing firms - Turnaround strategies - Concept of business valuation - Different valuation measurements - Nature of goodwill and how to measure it - Advantages and disadvantages of buying an established small firm - Process of preparing a business for sale.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1. Familiarise the students with the concept of small business

CO2. In depth knowledge on small business opportunities and challenges

CO3. Ability to devise plans for small business by building the right skills and marketing strategies

CO4. Identify the funding source for small start ups

CO5. Business evaluation for buying and selling of small firms

REFERENCES

1. Hankinson,A.(2000). "The key factors in the profile of small firm owner-managers that influence business performance. The South Coast Small Firms Survey, 1997-2000." Industrial and Commercial Training 32(3):94-98.
2. Parker,R.(2000). "Small is not necessarily beautiful: An evaluation of policy support for small and medium-sized enterprise in Australia." Australian Journal of Political Science 35(2):239-253.
3. Journal articles on SME's.

MAPPING OF POs AND COs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	1	-	-
CO2	3	3	3	3	2	3
CO3	3	3	2	2	3	3
CO4	3	2	2	2	1	1
CO5	3	2	2	3	2	1

OBA433 INTELLECTUAL PROPERTY RIGHTS L T P C
3 0 0 3

COURSE OBJECTIVE

- To understand intellectual property rights and its valuation.

UNIT I INTRODUCTION 9

Intellectual property rights - Introduction, Basic concepts, Patents, Copyrights, Trademarks, Trade Secrets, Geographic Indicators; Nature of Intellectual Property, Technological Research, Inventions and Innovations, History - the way from WTO to WIPO, TRIPS.

UNIT II PROCESS 9

New Developments in IPR, Procedure for grant of Patents, TM, GIs, Patenting under Patent Cooperation Treaty, Administration of Patent system in India, Patenting in foreign countries.

UNIT III STATUTES 9

International Treaties and conventions on IPRs, The TRIPs Agreement, PCT Agreement, The Patent Act of India, Patent Amendment Act (2005), Design Act, Trademark Act, Geographical Indication Act, Bayh- Dole Act and Issues of Academic Entrepreneurship.

UNIT IV STRATEGIES IN INTELLECTUAL PROPERTY 9

Strategies for investing in R&D, Patent Information and databases, IPR strength in India, Traditional Knowledge, Case studies.

UNIT V MODELS 9

The technologies Know-how, concept of ownership, Significance of IP in Value Creation, IP Valuation and IP Valuation Models, Application of Real Option Model in Strategic Decision Making, Transfer and Licensing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1: Understanding of intellectual property and appreciation of the need to protect it
CO2: Awareness about the process of patenting
CO3: Understanding of the statutes related to IPR
CO4: Ability to apply strategies to protect intellectual property
CO5: Ability to apply models for making strategic decisions related to IPR

REFERENCES

1. V. Sople Vinod, Managing Intellectual Property by (Prentice hall of India Pvt.Ltd), 2006.
2. Intellectual Property rights and copyrights, EssEss Publications.
3. Primer, R. Anita Rao and Bhanoji Rao, Intellectual Property Rights, Lastain Book company.

4. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2006.
5. WIPO Intellectual Property Hand book.

MAPPING OF POs AND COs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	2	3
CO2	3	3	2	3	1	3
CO3	3	3	3	3	2	3
CO4	3	3	3	2	1	3
CO5	3	3	3	2	2	3

OBA434 ETHICAL MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVE

- To help students develop knowledge and competence in ethical management and decision making in organizational contexts.

UNIT I ETHICS AND SOCIETY 9

Ethical Management- Definition, Motivation, Advantages-Practical implications of ethical management. Managerial ethics, professional ethics, and social Responsibility-Role of culture and society's expectations- Individual and organizational responsibility to society and the community.

UNIT II ETHICAL DECISION MAKING AND MANAGEMENT IN A CRISIS 9

Managing in an ethical crisis, the nature of a crisis, ethics in crisis management, discuss case studies, analyze real-world scenarios, develop ethical management skills, knowledge, and competencies. Proactive crisis management.

UNIT III STAKEHOLDERS IN ETHICAL MANAGEMENT 9

Stakeholders in ethical management, identifying internal and external stakeholders, nature of stakeholders, ethical management of various kinds of stakeholders: customers (product and service issues), employees (leadership, fairness, justice, diversity) suppliers, collaborators, business, community, the natural environment (the sustainability imperative, green management, Contemporary issues).

UNIT IV INDIVIDUAL VARIABLES IN ETHICAL MANJAGEMENT 9

Understanding individual variables in ethics, managerial ethics, concepts in ethical psychology-ethical awareness, ethical courage, ethical judgment, ethical foundations, ethical emotions/intuitions/intensity. Utilization of these concepts and competencies for ethical decision-making and management.

UNIT V PRACTICAL FIELD-GUIDE, TECHNIQUES AND SKILLS 9

Ethical management in practice, development of techniques and skills, navigating challenges and dilemmas, resolving issues and preventing unethical management proactively. Role modelling and creating a culture of ethical management and human flourishing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1: Role modelling and influencing the ethical and cultural context.
CO2: Respond to ethical crises and proactively address potential crises situations.
CO3: Understand and implement stakeholder management decisions.
CO4: Develop the ability, knowledge, and skills for ethical management.
CO5: Develop practical skills to navigate, resolve and thrive in management situations

REFERENCES

1. Brad Agle, Aaron Miller, Bill O' Rourke, The Business Ethics Field Guide: the essential companion to leading your career and your company, 2016.
2. Steiner & Steiner, Business, Government & Society: A managerial Perspective, 2011.
3. Lawrence & Weber, Business and Society: Stakeholders, Ethics, Public Policy, 2020.

MAPPING OF POs AND COs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	2	3
CO2		3	2	3	1	3
CO3	3	3	3	3	2	3
CO4	3	3	3	2	1	3
CO5	3	3	3	2	2	3

ET4251 IoT FOR SMART SYSTEMS LT P C
3 0 0 3

COURSE OBJECTIVES:

1. To study about **Internet of Things** technologies and its role in real time applications.
2. To introduce the infrastructure required for IoT
3. To familiarize the accessories and communication techniques for IoT.
4. To provide insight about the embedded processor and sensors required for IoT
5. To familiarize the different platforms and Attributes for IoT

UNIT I INTRODUCTION TO INTERNET OF THINGS 9

Overview, Hardware and software requirements for IOT, Sensor and actuators, Technology drivers, Business drivers, Typical IoT applications, Trends and implications.

UNIT II IOT ARCHITECTURE 9

IoT reference model and architecture -Node Structure - Sensing, Processing, Communication, Powering, Networking - Topologies, Layer/Stack architecture**,** IoT standards, Cloud computing for IoT, Bluetooth, Bluetooth Low Energy beacons.

UNIT III PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT 9

PROTOCOLS:

NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe GSM, CDMA, LTE, GPRS, small cell.

Wireless technologies for IoT: WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems-Recent trends.

UNIT IV IOT PROCESSORS 9

Services/Attributes: Big-Data Analytics for IOT, Dependability,Interoperability, Security, Maintainability.

Embedded processors for IOT :Introduction to Python programming -Building IOT with RASPERRY PI and Arduino.

UNIT V CASE STUDIES 9

Industrial IoT, Home Automation, smart cities, Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IOT Defense

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Analyze the concepts of IoT and its present developments.
CO2: Compare and contrast different platforms and infrastructures available for IoT
CO3: Explain different protocols and communication technologies used in IoT
CO4: Analyze the big data analytic and programming of IoT
CO5: Implement IoT solutions for smart applications

CO	PO					
	1	2	3	4	5	6
1	1	2	1	-	-	-
2	-	2	-	-	-	-
3	1	2	-	1	3	-
4	2		3	3	3	3
5	3	2	3	3	3	3
Avg.	1.75	2	2.33	2.33	3	2

REFERENCES:

1. ArshdeepBahga and VijaiMadisetti : A Hands-on Approach “Internet of Things”,Universities Press 2015.
2. Oliver Hersent , David Boswarthick and Omar Elloumi “ The Internet of Things”, Wiley,2016.
3. Samuel Greengard, “ The Internet of Things”, The MIT press, 2015.
4. Adrian McEwen and Hakim Cassimally“Designing the Internet of Things “Wiley,2014.
5. Jean- Philippe Vasseur, Adam Dunkels, “Interconnecting Smart Objects with IP: The Next Internet” Morgan Kuffmann Publishers, 2010.
6. Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, John Wiley and sons, 2014.
7. Lingyang Song/DusitNiyato/ Zhu Han/ Ekram Hossain,” Wireless Device-to-Device Communications and Networks, CAMBRIDGE UNIVERSITY PRESS,2015.
8. OvidiuVermesan and Peter Friess (Editors), “Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems”, River Publishers Series in Communication, 2013.

9. Vijay Madisetti , ArshdeepBahga, “Internet of Things (A Hands on-Approach)”, 2014.
10. Zach Shelby, Carsten Bormann, “6LoWPAN: The Wireless Embedded Internet”, John Wiley and sons, 2009.
11. Lars T.Berger and Krzysztof Iniewski, “Smart Grid applications, communications and security”, Wiley, 2015.
12. JanakaEkanayake, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama and Nick Jenkins, “ Smart Grid Technology and Applications”, Wiley, 2015.
13. UpenaDalal,”Wireless Communications & Networks,Oxford,2015.

ET4072 MACHINE LEARNING AND DEEP LEARNING L T P C
3 0 0 3

COURSE OBJECTIVES:

The course is aimed at

1. Understanding about the learning problem and algorithms
2. Providing insight about neural networks
3. Introducing the machine learning fundamentals and significance
4. Enabling the students to acquire knowledge about pattern recognition.
5. Motivating the students to apply deep learning algorithms for solving real life problems.

UNIT I LEARNING PROBLEMS AND ALGORITHMS 9

Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms

UNIT II NEURAL NETWORKS 9

Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation Training Algorithms for Pattern Association - Hebb rule and Delta rule, Hetero associative, Auto associative, Kohonen Self Organising Maps, Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning.

UNIT III MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS 9

Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering.

UNIT IV DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS 9

Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs.

UNIT V DEEP LEARNING: RNNS, AUTOENCODERS AND GANS 9

State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs

TOTAL : 45 PERIODS

COURSE OUTCOMES (CO):

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

CO1 : Illustrate the categorization of machine learning algorithms.

CO2: Compare and contrast the types of neural network architectures, activation functions

CO3: Acquaint with the pattern association using neural networks

CO4: Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks

CO5: Construct different feature selection and classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs.

CO	PO					
	1	2	3	4	5	6
1	1	3	1	-	-	-
2	2	3	2	-	-	-
3	3	-	3	-	3	-
4	2	3	3	-	-	-
5	3	3	3	-	3	-
6	3	3	3	-	3	-
7	3	3	3	-	3	-
Avg.	2.42	3	2.57	-	3	-

REFERENCES:

1. J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning
2. Deep Learning, Ian Good fellow, YoshuaBengio and Aaron Courville, MIT Press, ISBN: 9780262035613, 2016.
3. The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.
4. Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.
5. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.

PX4012 RENEWABLE ENERGY TECHNOLOGY L T P C

3 0 0 3

OBJECTIVES:

To impart knowledge on

- Different types of renewable energy technologies
- Standalone operation, grid connected operation of renewable energy systems

UNIT I INTRODUCTION 9

Classification of energy sources – Co2 Emission - Features of Renewable energy - Renewable energy scenario in India -Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment Per Capital Consumption - CO_2 Emission - importance of renewable energy sources, Potentials – Achievements– Applications.

UNIT II SOLAR PHOTOVOLTAICS 9

Solar Energy: Sun and Earth-Basic Characteristics of solar radiation- angle of sunrays on solar collector-Estimating Solar Radiation Empirically - Equivalent circuit of PV Cell- Photovoltaic cell-characteristics: P-V and I-V curve of cell-Impact of Temperature and Insolation on I-V characteristics-Shading Impacts on I-V characteristics-Bypass diode -Blocking diode.

UNIT III PHOTOVOLTAIC SYSTEM DESIGN 9

Block diagram of solar photo voltaic system : Line commutated converters (inversion mode) - Boost and buck-boost converters - selection of inverter, battery sizing, array sizing - PV systems classification- standalone PV systems - Grid tied and grid interactive inverters- grid connection issues.

UNIT IV WIND ENERGY CONVERSION SYSTEMS 9

Origin of Winds: Global and Local Winds- Aerodynamics of Wind turbine-Derivation of Betz's limit-Power available in wind-Classification of wind turbine: Horizontal Axis wind turbine and Vertical axis wind turbine- Aerodynamic Efficiency-Tip Speed-Tip Speed Ratio-Solidity-Blade Count-Power curve of wind turbine - Configurations of wind energy conversion systems: Type A, Type B, Type C and Type D Configurations- Grid connection Issues - Grid integrated SCIG and PMSG based WECS.

UNIT V OTHER RENEWABLE ENERGY SOURCES 9

Qualitative study of different renewable energy resources: ocean, Biomass, Hydrogen energy systems, Fuel cells, Ocean Thermal Energy Conversion (OTEC), Tidal and wave energy, Geothermal Energy Resources.

TOTAL : 45 PERIODS

OUTCOMES:

After completion of this course, the student will be able to:

CO1: Demonstrate the need for renewable energy sources.
CO2: Develop a stand-alone photo voltaic system and implement a maximum power point tracking in the PV system.
CO3: Design a stand-alone and Grid connected PV system.
CO4: Analyze the different configurations of the wind energy conversion systems.
CO5: Realize the basic of various available renewable energy sources

REFERENCES:

1. S.N.Bhadra, D. Kastha, & S. Banerjee "Wind Electrical Systems", Oxford UniversityPress, 2009.
2. Rai. G.D, "Non conventional energy sources", Khanna publishes, 1993.
3. Rai. G.D," Solar energy utilization", Khanna publishes, 1993.
4. Chetan Singh Solanki, "Solar Photovoltaics: Fundamentals, Technologies and Applications", PHI Learning Private Limited, 2012.
5. John Twideu and Tony Weir, "Renewal Energy Resources" BSP Publications, 2006
6. Gray, L. Johnson, "Wind energy system", prentice hall of India, 1995.

7. B.H.Khan, " Non-conventional Energy sources", , McGraw-hill, 2nd Edition, 2009.
8. Fang Lin Luo Hong Ye, " Renewable Energy systems", Taylor & Francis Group,2013.

CO-PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		2	2	2	1
CO2	3		2	3	3	3
CO3	3		2	3	3	3
CO4	3		2	3	3	2
CO5	3		2	2	2	2

PS4093 SMART GRID L T P C
3 0 0 3

COURSE OBJECTIVES

- To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
- To know about the function of smart grid.
- To familiarize the power quality management issues in Smart Grid.
- To familiarize the high performance computing for Smart Grid applications
- To get familiarized with the communication networks for Smart Grid applications

UNIT I INTRODUCTION TO SMART GRID 9

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Comparison of Micro grid and Smart grid, Present development & International policies in Smart Grid, Smart Grid Initiative for Power Distribution Utility in India – Case Study.

UNIT II SMART GRID TECHNOLOGIES 9

Technology Drivers, Smart Integration of energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV) – Grid to Vehicle and Vehicle to Grid charging concepts.

UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU) & their application for monitoring & protection. Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.

UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID 9

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Unit V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

Architecture and Standards -Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), PLC, Zigbee, GSM, IP based Protocols, Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.

TOTAL : 45 PERIODS

COURSE OUTCOME:

Students able to

CO1: Relate with the smart resources, smart meters and other smart devices.
CO2: Explain the function of Smart Grid.
CO3: Experiment the issues of Power Quality in Smart Grid.
CO4: Analyze the performance of Smart Grid.
CO5**:** Recommend suitable communication networks for smart grid applications

REFERENCES

1. Stuart Borlase 'Smart Grid: Infrastructure, Technology and Solutions', CRC Press 2012.
2. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, 'Smart Grid: Technology and Applications', Wiley, 2012.
3. Mini S. Thomas, John D McDonald, 'Power System SCADA and Smart Grids', CRC Press, 2015
4. Kenneth C.Budka, Jayant G. Deshpande, Marina Thottan, 'Communication Networks for Smart Grids', Springer, 2014
5. SMART GRID Fundamentals of Design and Analysis, James Momoh, IEEE press, A John Wiley & Sons, Inc., Publication.

MAPPING OF CO'S WITH PO'S

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	3	2	-	2	2	2
2	3	-	2	2	-	2
3	2	-	1	-	-	-
4	1	-	-	3	3	1
5	-	2	2	2	2	3
AVG	2.25	2	1.66	2.25	2.3	2

CP4391 SECURITY PRACTICES L T P C

3 0 0 3

COURSE OBJECTIVES:

- To learn the core fundamentals of system and web security concepts
- To have through understanding in the security concepts related to networks
- To deploy the security essentials in IT Sector
- To be exposed to the concepts of Cyber Security and cloud security
- To perform a detailed study of Privacy and Storage security and related Issues

UNIT I SYSTEM SECURITY 9

Model of network security – Security attacks, services and mechanisms – OSI security architecture -A Cryptography primer- Intrusion detection system- Intrusion Prevention system - Security web applications- Case study: OWASP - Top 10 Web Application Security Risks.

UNIT II NETWORK SECURITY 9

Internet Security - Intranet security- Local Area Network Security - Wireless Network Security - Wireless Sensor Network Security- Cellular Network Security - Mobile security - IOT security - Case Study - Kali Linux.

UNIT III SECURITY MANAGEMENT 9

Information security essentials for IT Managers- Security Management System - Policy Driven System Management- IT Security - Online Identity and User Management System. Case study: Metasploit

UNIT IV CYBER SECURITY AND CLOUD SECURITY 9

Cyber Forensics- Disk Forensics – Network Forensics – Wireless Forensics – Database Forensics – Malware Forensics – Mobile Forensics – Email Forensics- Best security practices for automate Cloud infrastructure management – Establishing trust in IaaS, PaaS, and SaaS Cloud types. Case study: DVWA

UNIT V PRIVACY AND STORAGE SECURITY 9

Privacy on the Internet - Privacy Enhancing Technologies - Personal privacy Policies - Detection of Conflicts in security policies- privacy and security in environment monitoring systems. Storage Area Network Security - Storage Area Network Security Devices - Risk management - Physical Security Essentials.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Understand the core fundamentals of system security
CO2: Apply the security concepts to wired and wireless networks
CO3: Implement and Manage the security essentials in IT Sector
CO4: Explain the concepts of Cyber Security and Cyber forensics
CO5: Be aware of Privacy and Storage security Issues.

REFERENCES

1. John R. Vacca, Computer and Information Security Handbook, Third Edition, Elsevier 2017
2. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Seventh Edition, Cengage Learning, 2022
3. Richard E. Smith, Elementary Information Security, Third Edition, Jones and Bartlett Learning, 2019
4. Mayor, K.K.Mookhey, Jacopo Cervini, Fairuzan Roslan, Kevin Beaver, Metasploit Toolkit for Penetration Testing, Exploit Development and Vulnerability Research, Syngress publications, Elsevier, 2007. ISBN : 978-1-59749-074-0
5. John Sammons, “The Basics of Digital Forensics- The Primer for Getting Started in Digital Forensics”, Syngress, 2012
6. Cory Altheide and Harlan Carvey, “Digital Forensics with Open Source Tools”,2011 Syngress, ISBN: 9781597495875.
7. Siani Pearson, George Yee "Privacy and Security for Cloud Computing" Computer Communications and Networks, Springer, 2013.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	2	1	1	2	1
2	2	1	3	1	1	2
3			2	3	3	3
4	2	2	1	2	1	3
5	1		1	1	2	3
Avg	1.50	1.67	1.60	1.60	1.80	2.40

MP4251 CLOUD COMPUTING TECHNOLOGIES L T P C
3 0 0 3

COURSE OBJECTIVES:

- To gain expertise in Virtualization, Virtual Machines and deploy practical virtualization solution
- To understand the architecture, infrastructure and delivery models of cloud computing.
- To explore the roster of AWS services and illustrate the way to make applications in AWS
- To gain knowledge in the working of Windows Azure and Storage services offered by Windows Azure
- To develop the cloud application using various programming model of Hadoop and Aneka

UNIT I VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTURE 6

Basics of Virtual Machines - Process Virtual Machines – System Virtual Machines –Emulation – Interpretation – Binary Translation - Taxonomy of Virtual Machines. Virtualization –Management Virtualization — Hardware Maximization – Architectures – Virtualization Management – Storage Virtualization – Network Virtualization- Implementation levels of virtualization – virtualization structure – virtualization of CPU, Memory and I/O devices – virtual clusters and Resource Management – Virtualization for data center automation

UNIT II CLOUD PLATFORM ARCHITECTURE 12

Cloud Computing: Definition, Characteristics - Cloud deployment models: public, private, hybrid, community – Categories of cloud computing: Everything as a service: Infrastructure, platform, software- A Generic Cloud Architecture Design – Layered cloud Architectural Development – Architectural Design Challenges

UNIT III AWS CLOUD PLATFORM - IAAS 9

Amazon Web Services: AWS Infrastructure- AWS API- AWS Management Console - Setting up AWS Storage - Stretching out with Elastic Compute Cloud - Elastic Container Service for Kubernetes- AWS Developer Tools: AWS Code Commit, AWS Code Build, AWS Code Deploy, AWS Code Pipeline, AWS code Star - AWS Management Tools: Cloud Watch, AWS Auto Scaling, AWS control Tower, Cloud Formation, Cloud Trail, AWS License Manager

UNIT IV PAAS CLOUD PLATFORM 9

Windows Azure: Origin of Windows Azure, Features, The Fabric Controller – First Cloud APP in Windows Azure- Service Model and Managing Services: Definition and Configuration, Service runtime API- Windows Azure Developer Portal- Service Management API- Windows Azure Storage Characteristics-Storage Services- REST API- Blops

UNIT V PROGRAMMING MODEL **9**

Introduction to Hadoop Framework - Mapreduce, Input splitting, map and reduce functions, specifying input and output parameters, configuring and running a job –Developing Map Reduce Applications - Design of Hadoop file system –Setting up Hadoop Cluster- Aneka: Cloud Application Platform, Thread Programming, Task Programming and Map-Reduce Programming in Aneka

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Employ the concepts of virtualization in the cloud computing
CO2: Identify the architecture, infrastructure and delivery models of cloud computing
CO3: Develop the Cloud Application in AWS platform
CO4: Apply the concepts of Windows Azure to design Cloud Application
CO5: Develop services using various Cloud computing programming models.

REFERENCES

1. Bernard Golden, Amazon Web Service for Dummies, John Wiley & Sons, 2013.
2. Raoul Alongi, AWS: The Most Complete Guide to Amazon Web Service from Beginner to Advanced Level, Amazon Asia- Pacific Holdings Private Limited, 2019.
3. Sriram Krishnan, Programming: Windows Azure, O'Reilly,2010.
4. Rajkumar Buyya, Christian Vacchiola, S.Thamarai Selvi, Mastering Cloud Computing , MCGraw Hill Education (India) Pvt. Ltd., 2013.
5. Danielle Ruest, Nelson Ruest, —Virtualization: A Beginner"s Guidell, McGraw-Hill Osborne Media, 2009.
6. Jim Smith, Ravi Nair , "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.
7. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.
8. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGraw-Hill Osborne Media, 2009.
9. Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2012.

IF4072 DESIGN THINKING **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To provide a sound knowledge in UI & UX
- To understand the need for UI and UX
- Research Methods used in Design
- Tools used in UI & UX
- Creating a wireframe and prototype

UNIT I UX LIFECYCLE TEMPLATE **8**

Introduction. A UX process lifecycle template. Choosing a process instance for your project. The system complexity space. Meet the user interface team. Scope of UX presence within the team. More about UX lifecycles. Business Strategy. Value Innovation. Validated User Research. Killer UX Design. The Blockbuster Value Proposition. What Is a Value Proposition?.

UNIT II CONTEXTUAL INQUIRY 10

The system concept statement. User work activity data gathering. Look for emotional aspects of work practice. Abridged contextual inquiry process. Data-driven vs. model-driven inquiry. Organizing concepts: work roles and flow model. Creating and managing work activity notes. Constructing your work activity affinity diagram (WAAD). Abridged contextual analysis process. History of affinity diagrams.

UNIT III DESIGN THINKING, IDEATION, AND SKETCHING 9

Design-informing models: second span of the bridge . Some general “how to” suggestions. A New example domain: slideshow presentations. User models. Usage models. Work environment models. Barrier summaries. Model consolidation. Protecting your sources. Abridged methods for design-informing models extraction. Design paradigms. Design thinking. Design perspectives. User personas. Ideation. Sketching

UNIT IV UX GOALS, METRICS, AND TARGETS 8

Introduction. UX goals. UX target tables. Work roles, user classes, and UX goals. UX measures. Measuring instruments. UX metrics. Baseline level. Target level. Setting levels. Observed results. Practical tips and cautions for creating UX targets. How UX targets help manage the user experience engineering process.

UNIT V ANALYSING USER EXPERIENCE 10

Sharpening Your Thinking Tools. UX Research and Strength of Evidence. Agile Personas. How to Prioritize Usability Problems. Creating Insights, Hypotheses and Testable Design Ideas. How to Manage Design Projects with User Experience Metrics. Two Measures that Will Justify Any Design Change. Evangelizing UX Research. How to Create a User Journey Map. Generating Solutions to Usability Problems. Building UX Research Into the Design Studio Methodology. Dealing with Common objections to UX Research. The User Experience Debrief Meeting. Creating a User Experience Dashboard.

SUGGESTED ACTIVITIES:

1: Hands on Design Thinking process for a product
2: Defining the Look and Feel of any new Project
3: Create a Sample Pattern Library for that product (Mood board, Fonts, Colors based on UI principles)
4: Identify a customer problem to solve.
5: Conduct end-to-end user research - User research, creating personas, Ideation process (User stories, Scenarios), Flow diagrams, Flow Mapping

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Build UI for user Applications
CO2: Use the UI Interaction behaviors and principles
CO3: Evaluate UX design of any product or application
CO4: Demonstrate UX Skills in product development
CO5: Implement Sketching principles

REFERENCES

1. UX for Developers: How to Integrate User-Centered Design Principles Into Your Day-to-Day Development Work, Westley Knight. Apress, 2018
2. The UX Book: Process and Guidelines for Ensuring a Quality User Experience, Rex Hartson, Pardha Pyla. Morgan Kaufmann, 2012
3. UX Fundamentals for Non-UX Professionals: User Experience Principles for Managers,

Writers, Designers, and Developers, Edward Stull. Apress, 2018
4. Lean UX: Designing Great Products with Agile Teams, Gothelf, Jeff, Seiden, and Josh. O'Reilly Media, 2016
5. Designing UX: Prototyping: Because Modern Design is Never Static, Ben Coleman, and Dan Goodwin. SitePoint, 2017

MU4153 PRINCIPLES OF MULTIMEDIA L T P C
3 0 0 3

COURSE OBJECTIVES:

- To get familiarity with gamut of multimedia and its significance
- To acquire knowledge in multimedia components.
- To acquire knowledge about multimedia tools and authoring.
- To acquire knowledge in the development of multimedia applications.
- To explore the latest trends and technologies in multimedia

UNIT I INTRODUCTION 9

Introduction to Multimedia – Characteristics of Multimedia Presentation – Multimedia Components – Promotion of Multimedia Based Components – Digital Representation – Media and Data Streams – Multimedia Architecture – Multimedia Documents, Multimedia Tasks and Concerns, Production, sharing and distribution, Hypermedia, WWW and Internet, Authoring, Multimedia over wireless and mobile networks.

Suggested Activities:

1. Flipped classroom on media Components.
2. External learning – Interactive presentation.

Suggested Evaluation Methods:

1. Tutorial – Handling media components
2. Quizzes on different types of data presentation.

UNIT II ELEMENTS OF MULTIMEDIA 9

Text-Types, Font, Unicode Standard, File Formats, Graphics and Image data representations – data types, file formats, color models; video – color models in video, analog video, digital video, file formats, video display interfaces, 3D video and TV: Audio – Digitization, SNR, SQNR, quantization, audio quality, file formats, MIDI; Animation- Key Frames and Tweening, other Techniques, 2D and 3D Animation.

Suggested Activities:

1. Flipped classroom on different file formats of various media elements.
2. External learning – Adobe after effects, Adobe Media Encoder, Adobe Audition.

Suggested Evaluation Methods:

1. Demonstration on after effects animations.
2. Quizzes on file formats and color models.

UNIT III MULTIMEDIA TOOLS 9

Authoring Tools – Features and Types – Card and Page Based Tools – Icon and Object Based Tools – Time Based Tools – Cross Platform Authoring Tools – Editing Tools – Painting and Drawing Tools – 3D Modeling and Animation Tools – Image Editing Tools – Sound Editing Tools – Digital Movie Tools.

Suggested Activities:

1. Flipped classroom on multimedia tools.
2. External learning – Comparison of various authoring tools.

Suggested Evaluation Methods:

1. Tutorial – Audio editing tool.
2. Quizzes on animation tools.

UNIT IV MULTIMEDIA SYSTEMS 9

Compression Types and Techniques: CODEC, Text Compression: GIF Coding Standards, JPEG standard – JPEG 2000, basic audio compression – ADPCM, MPEG Psychoacoustics, basic Video compression techniques – MPEG, H.26X – Multimedia Database System – User Interfaces – OS Multimedia Support – Hardware Support – Real Time Protocols – Play Back Architectures – Synchronization – Document Architecture – Hypermedia Concepts: Hypermedia Design – Digital Copyrights, Content analysis.

Suggested Activities:

1. Flipped classroom on concepts of multimedia hardware architectures.
2. External learning – Digital repositories and hypermedia design.

Suggested Evaluation Methods:

1. Quizzes on multimedia hardware and compression techniques.
2. Tutorial – Hypermedia design.

UNIT V MULTIMEDIA APPLICATIONS FOR THE WEB AND MOBILE PLATFORMS 9

ADDIE Model – Conceptualization – Content Collection – Storyboard–Script Authoring Metaphors – Testing – Report Writing – Documentation. Multimedia for the web and mobile platforms. Virtual Reality, Internet multimedia content distribution, Multimedia Information sharing – social media sharing, cloud computing for multimedia services, interactive cloud gaming. Multimedia information retrieval.

Suggested Activities:

1. External learning – Game consoles.
2. External learning – VRML scripting languages.

Suggested Evaluation Methods:

1. Demonstration of simple interactive games.
2. Tutorial – Simple VRML program.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Handle the multimedia elements effectively.
CO2: Articulate the concepts and techniques used in multimedia applications.
CO3: Develop effective strategies to deliver Quality of Experience in multimedia applications.
CO4: Design and implement algorithms and techniques applied to multimedia objects.
CO5: Design and develop multimedia applications following software engineering models.

REFERENCES:
1. Li, Ze-Nian, Drew, Mark, Liu, Jiangchuan, “Fundamentals of Multimedia”, Springer, Third Edition, 2021.
2. Prabhat K.Andleigh, Kiran Thakrar, “MULTIMEDIA SYSTEMS DESIGN”, Pearson Education, 2015.
3. Gerald Friedland, Ramesh Jain, “Multimedia Computing”, Cambridge University Press, 2018. (digital book)
4. Ranjan Parekh, “Principles of Multimedia”, Second Edition, McGraw-Hill Education, 2017

DS4015 **BIG DATA ANALYTICS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:
- To understand the basics of big data analytics
- To understand the search methods and visualization
- To learn mining data streams
- To learn frameworks
- To gain knowledge on R language

UNIT I INTRODUCTION TO BIG DATA 9

Introduction to Big Data Platform – Challenges of Conventional Systems - Intelligent data analysis –Nature of Data - Analytic Processes and Tools - Analysis Vs Reporting - Modern Data Analytic Tools- Statistical Concepts: Sampling Distributions - Re-Sampling - Statistical Inference - Prediction Error.

UNIT II SEARCH METHODS AND VISUALIZATION 9

Search by simulated Annealing – Stochastic, Adaptive search by Evaluation – Evaluation Strategies –Genetic Algorithm – Genetic Programming – Visualization – Classification of Visual Data Analysis Techniques – Data Types – Visualization Techniques – Interaction techniques – Specific Visual data analysis Techniques

UNIT III MINING DATA STREAMS 9

Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window - Real time Analytics Platform(RTAP) Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions

UNIT IV FRAMEWORKS 9

MapReduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases - S3 - Hadoop Distributed File Systems – Case Study- Preventing Private Information Inference Attacks on Social Networks- Grand Challenge: Applying Regulatory Science and Big Data to Improve Medical Device Innovation

UNIT V R LANGUAGE 9

Overview, Programming structures: Control statements -Operators -Functions -Environment and scope issues -Recursion -Replacement functions, R data structures: Vectors -Matrices and arrays -Lists -Data frames -Classes, Input/output, String manipulations

COURSE OUTCOMES:

CO1:understand the basics of big data analytics

CO2: Ability to use Hadoop, Map Reduce Framework.

CO3: Ability to identify the areas for applying big data analytics for increasing the business outcome.

CO4:gain knowledge on R language

CO5: Contextually integrate and correlate large amounts of information to gain faster insights.

TOTAL:45 PERIODS

REFERENCE:

1. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.
2. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 3rd edition 2020.
3. Norman Matloff, The Art of R Programming: A Tour of Statistical Software Design, No Starch Press, USA, 2011.
4. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, John Wiley & sons, 2012.
5. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	3	3	2	1
2	3	3	3	3	2	1
3	3	3	3	3	2	1
4	3	3	3	3	2	1
5	3	3	3	3	2	1
Avg	3	3	3	3	2	1

NC4201 INTERNET OF THINGS AND CLOUD L T P C

3 0 0 3

COURSE OBJECTIVES:

- To understand Smart Objects and IoT Architectures
- To learn about various IOT-related protocols
- To build simple IoT Systems using Arduino and Raspberry Pi.
- To understand data analytics and cloud in the context of IoT
- To develop IoT infrastructure for popular applications

UNIT I FUNDAMENTALS OF IoT 9

Introduction to IoT – IoT definition – Characteristics – IoT Complete Architectural Stack – IoT enabling Technologies – IoT Challenges. Sensors and Hardware for IoT – Hardware Platforms – Arduino, Raspberry Pi, Node MCU. A Case study with any one of the boards and data acquisition from sensors.

UNIT II PROTOCOLS FOR IoT 9

Infrastructure protocol (IPV4/V6/RPL), Identification (URIs), Transport (Wifi, Lifi, BLE), Discovery, Data Protocols, Device Management Protocols. – A Case Study with MQTT/CoAP usage-IoT privacy, security and vulnerability solutions.

UNIT III CASE STUDIES/INDUSTRIAL APPLICATIONS 9

Case studies with architectural analysis: IoT applications – Smart City – Smart Water – Smart Agriculture – Smart Energy – Smart Healthcare – Smart Transportation – Smart Retail – Smart waste management.

UNIT IV CLOUD COMPUTING INTRODUCTION 9

Introduction to Cloud Computing - Service Model – Deployment Model- Virtualization Concepts – Cloud Platforms – Amazon AWS – Microsoft Azure – Google APIs.

UNIT V IoT AND CLOUD 9

IoT and the Cloud - Role of Cloud Computing in IoT - AWS Components - S3 – Lambda - AWS IoT Core -Connecting a web application to AWS IoT using MQTT- AWS IoT Examples. Security Concerns, Risk Issues, and Legal Aspects of Cloud Computing- Cloud Data Security

TOTAL:45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the various concept of the IoT and their technologies..
CO2: Develop IoT application using different hardware platforms
CO3: Implement the various IoT Protocols
CO4: Understand the basic principles of cloud computing.
CO5: Develop and deploy the IoT application into cloud environment

REFERENCES

1. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman ,CRC Press, 2017
2. Adrian McEwen, Designing the Internet of Things, Wiley,2013.
3. EMC Education Services, “Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data”, Wiley publishers, 2015.
4. Simon Walkowiak, “Big Data Analytics with R” PackT Publishers, 2016
5. Bart Baesens, “Analytics in a Big Data World: The Essential Guide to Data Science and its Applications”, Wiley Publishers, 2015.

MX4073 MEDICAL ROBOTICS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To explain the basic concepts of robots and types of robots
- To discuss the designing procedure of manipulators, actuators and grippers
- To impart knowledge on various types of sensors and power sources
- To explore various applications of Robots in Medicine
- To impart knowledge on wearable robots

UNIT I INTRODUCTION TO ROBOTICS 9

Introduction to Robotics, Overview of robot subsystems, Degrees of freedom, configurations and

concept of workspace, Dynamic Stabilization

Sensors and Actuators

Sensors and controllers, Internal and external sensors, position, velocity and acceleration sensors, Proximity sensors, force sensors Pneumatic and hydraulic actuators, Stepper motor control circuits, End effectors, Various types of Grippers, PD and PID feedback actuator models

UNIT II MANIPULATORS & BASIC KINEMATICS 9

Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and pneumatic manipulator, Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse Kinematic problems

Navigation and Treatment Planning

Variable speed arrangements, Path determination – Machinery vision, Ranging – Laser – Acoustic, Magnetic, fiber optic and Tactile sensor

UNIT III SURGICAL ROBOTS 9

Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump, CABG surgery, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric and General Surgery, Gynecologic Surgery, General Surgery and Nanorobotics. Case Study

UNIT IV REHABILITATION AND ASSISTIVE ROBOTS 9

Pediatric Rehabilitation, Robotic Therapy for the Upper Extremity and Walking, Clinical-Based Gait Rehabilitation Robots, Motion Correlation and Tracking, Motion Prediction, Motion Replication. Portable Robot for Tele rehabilitation, Robotic Exoskeletons – Design considerations, Hybrid assistive limb. Case Study

UNIT V WEARABLE ROBOTS 9

Augmented Reality, Kinematics and Dynamics for Wearable Robots, Wearable Robot technology, Sensors, Actuators, Portable Energy Storage, Human–robot cognitive interaction (cHRI), Human–robot physical interaction (pHRI), Wearable Robotic Communication - case study

TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1: Describe the configuration, applications of robots and the concept of grippers and actuators
CO2: Explain the functions of manipulators and basic kinematics
CO3: Describe the application of robots in various surgeries
CO4: Design and analyze the robotic systems for rehabilitation
CO5: Design the wearable robots

REFERENCES

1. Nagrath and Mittal, “Robotics and Control”, Tata McGraw Hill, First edition, 2003
2. Spong and Vidhyasagar, “Robot Dynamics and Control”, John Wiley and Sons, First edition, 2008
3. Fu.K.S, Gonzalez. R.C., Lee, C.S.G, “Robotics, control”, sensing, Vision and Intelligence, Tata McGraw Hill International, First edition, 2008
4. Bruno Siciliano, Oussama Khatib, Springer Handbook of Robotics, 1st Edition, Springer, 2008
5. Shane (S.Q.) Xie, Advanced Robotics for Medical Rehabilitation - Current State of the Art and Recent Advances, Springer, 2016
6. Sashi S Kommu, Rehabilitation Robotics, I-Tech Education and Publishing, 2007
7. Jose L. Pons, Wearable Robots: Biomechatronic Exoskeletons, John Wiley & Sons Ltd, England, 2008

8. Howie Choset, Kevin Lynch, Seth Hutchinson, “Principles of Robot Motion: Theory, Algorithms, and Implementations”, Prentice Hall of India, First edition, 2005
9. Philippe Coiffet, Michel Chirouze, “An Introduction to Robot Technology”, Tata McGraw Hill, First Edition, 1983
10. Jacob Rosen, Blake Hannaford & Richard M Satava, “Surgical Robotics: System Applications & Visions”, Springer 2011
11. Jocelyn Troccaz, Medical Robotics, Wiley, 2012
12. Achim Schweikard, Floris Ernst, Medical Robotics, Springer, 2015

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1				1		
2				2		
3	2		2	2	2	2
4	2		2	2	3	2
5	2		2	2	3	3
Avg	**2**		**2**	**1.8**	**2.6**	**2.3**

VE4202 EMBEDDED AUTOMATION L T P C
3 0 0 3

COURSE OBJECTIVES:

- To learn about the process involved in the design and development of real-time embedded system
- To develop the embedded C programming skills on 8-bit microcontroller
- To study about the interfacing mechanism of peripheral devices with 8-bit microcontrollers
- To learn about the tools, firmware related to microcontroller programming
- To build a home automation system

UNIT - I INTRODUCTION TO EMBEDDED C PROGRAMMING 9

C Overview and Program Structure - C Types, Operators and Expressions - C Control Flow - C Functions and Program Structures - C Pointers And Arrays - FIFO and LIFO - C Structures - Development Tools

UNIT - II AVR MICROCONTROLLER 9

ATMEGA 16 Architecture - Nonvolatile and Data Memories - Port System - Peripheral Features : Time Base, Timing Subsystem, Pulse Width Modulation, USART, SPI, Two Wire Serial Interface, ADC, Interrupts - Physical and Operating Parameters

UNIT – III HARDWARE AND SOFTWARE INTERFACING WITH 8-BIT SERIES CONTROLLERS 9

Lights and Switches - Stack Operation - Implementing Combinational Logic - Expanding I/O - Interfacing Analog To Digital Convertors - Interfacing Digital To Analog Convertors - LED Displays : Seven Segment Displays, Dot Matrix Displays - LCD Displays - Driving Relays - Stepper Motor Interface - Serial EEPROM - Real Time Clock - Accessing Constants Table - Arbitrary Waveform Generation - Communication Links - System Development Tools

UNIT – IV VISION SYSTEM 9

Fundamentals of Image Processing - Filtering - Morphological Operations - Feature Detection and Matching - Blurring and Sharpening - Segmentation - Thresholding - Contours - Advanced Contour Properties - Gradient - Canny Edge Detector - Object Detection - Background Subtraction

UNIT – V HOME AUTOMATION 9

Home Automation - Requirements - Water Level Notifier - Electric Guard Dog - Tweeting Bird Feeder - Package Delivery Detector - Web Enabled Light Switch - Curtain Automation - Android Door Lock - Voice Controlled Home Automation - Smart Lighting - Smart Mailbox - Electricity Usage Monitor -Proximity Garage Door Opener - Vision Based Authentic Entry System

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, students will be able to

CO1: analyze the 8-bit series microcontroller architecture, features and pin details
CO2: write embedded C programs for embedded system application
CO3: design and develop real time systems using AVR microcontrollers
CO4: design and develop the systems based on vision mechanism
CO5: design and develop a real time home automation system

REFERENCES:

1. Dhananjay V. Gadre, "Programming and Customizing the AVR Microcontroller", McGraw-Hill, 2001.
2. Joe Pardue, "C Programming for Microcontrollers ", Smiley Micros, 2005.
3. Steven F. Barrett, Daniel J. Pack, "ATMEL AVR Microcontroller Primer : Programming and Interfacing", Morgan & Claypool Publishers, 2012
4. Mike Riley, "Programming Your Home - Automate With Arduino, Android and Your Computer", the Pragmatic Programmers, Llc, 2012.
5. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2011.
6. Kevin P. Murphy, "Machine Learning - a Probabilistic Perspective", the MIT Press Cambridge, Massachusetts, London, 2012.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1		1	1	1	
2	1	3	1	1	1	3
3	1	3	1	1	1	3
4	1	3	1	1	1	3
5	1	3	1	1	1	3
Avg	(5/5)=1	(12/4)=3	(5/5)=1	(5/5)=1	(5/5)=1	(12/4)=3

CX4016 ENVIRONMENTAL SUSTAINABILITY L T P C

3 0 0 3

UNIT I INTRODUCTION 9

Valuing the Environment: Concepts, Valuing the Environment: Methods, Property Rights, Externalities, and Environmental Problems

UNIT II CONCEPT OF SUSTAINABILITY 9

Sustainable Development: Defining the Concept, the Population Problem, Natural Resource Economics: An Overview, Energy, Water, Agriculture

UNIT III SIGNIFICANCE OF BIODIVERSITY 9

Biodiversity, Forest Habitat, Commercially Valuable Species, Stationary - Source Local Air Pollution, Acid Rain and Atmospheric Modification, Transportation

UNIT IV POLLUTION IMPACTS 9

Water Pollution, Solid Waste and Recycling, Toxic Substances and Hazardous Wastes, Global Warming.

UNIT V ENVIRONMENTAL ECONOMICS 9

Development, Poverty, and the Environment, Visions of the Future, Environmental economics and policy by Tom Tietenberg, Environmental Economics

TOTAL : 45 PERIODS

REFERENCES

1. Andrew Hoffman, Competitive Environmental Strategy - A Guide for the Changing Business Landscape, Island Press.
2. Stephen Doven, Environment and Sustainability Policy: Creation, Implementation, Evaluation, the Federation Press, 2005
3. Robert Brinkmann., Introduction to Sustainability, Wiley-Blackwell., 2016
4. Niko Roorda., Fundamentals of Sustainable Development, 3rd Edn, Routledge, 2020
5. Bhavik R Bakshi., Sustainable Engineering: Principles and Practice, Cambridge University Press, 2019

TX4092 TEXTILE REINFORCED COMPOSITES L T P C

3 0 0 3

UNIT I REINFORCEMENTS 9

Introduction – composites –classification and application; reinforcements- fibres and its properties; preparation of reinforced materials and quality evaluation; preforms for various composites

UNIT II MATRICES 9

Preparation, chemistry, properties and applications of thermoplastic and thermoset resins; mechanism of interaction of matrices and reinforcements; optimization of matrices

UNIT III COMPOSITE MANUFACTURING 9

Classification; methods of composites manufacturing for both thermoplastics and thermosets- Hand layup, Filament Winding, Resin transfer moulding, prepregs and autoclave moulding, pultrusion, vacuum impregnation methods, compression moulding; post processing of composites and composite design requirements

UNIT IV TESTING 9

Fibre volume and weight fraction, specif ic gravity of composites, tensile, f lexural, impact,

compression, inter laminar shear stress and fatigue properties of thermoset and thermoplastic composites.

UNIT V MECHANICS 9

Micro mechanics, macro mechanics of single layer, macro mechanics of laminate, classical lamination theory, failure theories and prediction of inter laminar stresses using at ware

TOTAL: 45 PERIODS

REFERENCES

1. BorZ.Jang,"Advanced Polymer composites",ASM International,USA,1994.
2. Carlsson L.A. and Pipes R.B., "Experimental Characterization of advanced composite Materials",SecondEdition,CRCPress,NewJersey,1996.
3. George LubinandStanley T.Peters, "Handbook of Composites", Springer Publications,1998.
4. Mel. M. Schwartz, "Composite Materials", Vol. 1 &2, Prentice Hall PTR, New Jersey,1997.
5. RichardM.Christensen,"Mechanics of compositematerials",DoverPublications,2005.
6. Sanjay K. Mazumdar, "Composites Manufacturing: Materials, Product, and Process Engineering",CRCPress,2001

NT4002 NANOCOMPOSITE MATERIALS L T P C
3 0 0 3

UNIT I BASICS OF NANOCOMPOSITES 9

Nomenclature, Properties, features and processing of nanocomposites. Sample Preparation and Characterization of Structure and Physical properties. Designing, stability and mechanical properties and applications of super hard nanocomposites.

UNIT II METAL BASED NANOCOMPOSITES 9

Metal-metal nanocomposites, some simple preparation techniques and their properties. Metal-Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques and their final properties and functionality. Fractal based glass-metal nanocomposites, its designing and fractal dimension analysis. Core-Shell structured nanocomposites

UNIT III POLYMER BASED NANOCOMPOSITES 9

Preparation and characterization of diblock Copolymer based nanocomposites; Polymer Carbon nanotubes based composites, their mechanical properties, and industrial possibilities.

UNIT IV NANOCOMPOSITE FROM BIOMATERIALS 9

Natural nanocomposite systems - spider silk, bones, shells; organic-inorganic nanocomposite formation through self-assembly. Biomimetic synthesis of nanocomposites material; Use of synthetic nanocomposites for bone, teeth replacement.

UNIT V NANOCOMPOSITE TECHNOLOGY 9

Nanocomposite membrane structures- Preparation and applications. Nanotechnology in Textiles and Cosmetics-Nano-fillers embedded polypropylene fibers – Soil repellence, Lotus effect - Nano

finishing in textiles (UV resistant, anti-bacterial, hydrophilic, self-cleaning, flame retardant finishes), Sun-screen dispersions for UV protection using titanium oxide – Colour cosmetics. Nanotechnology in Food Technology - Nanopackaging for enhanced shelf life - Smart/Intelligent packaging.

TOTAL : 45 PERIODS

REFERENCES:

1. Introduction to Nanocomposite Materials. Properties, Processing, Characterization- Thomas E. Twardowski. 2007. DEStech Publications. USA.
2. Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V.Braun 2006.
3. Physical Properties of Carbon Nanotubes- R. Saito 1998.
4. Carbon Nanotubes (Carbon , Vol 33) - M. Endo, S. Iijima, M.S. Dresselhaus 1997.
5. The search for novel, superhard materials- Stan Vepr¡ek (Review Article) JVST A, 1999
6. Nanometer versus micrometer-sized particles-Christian Brosseau, Jamal BeN Youssef, Philippe Talbot, Anne-Marie Konn, (Review Article) J. Appl. Phys, Vol 93, 2003
7. Diblock Copolymer, - Aviram (Review Article), Nature, 2002
8. Bikramjit Basu, Kantesh Balani Advanced Structural Ceramics, A John Wiley & Sons, Inc.,
9. P. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead publication, London, 2006

BY4016 IPR, BIOSAFETY AND ENTREPRENEURSHIP L T P C
3 0 0 3

UNIT I IPR 9

Intellectual property rights – Origin of the patent regime – Early patents act & Indian pharmaceutical industry – Types of patents – Patent Requirements – Application preparation filing and prosecution – Patentable subject matter – Industrial design, Protection of GMO's IP as a factor in R&D,IP's of relevance to biotechnology and few case studies.

UNIT II AGREEMENTS, TREATIES AND PATENT FILING PROCEDURES 9

History of GATT Agreement – Madrid Agreement – Hague Agreement – WIPO Treaties – Budapest Treaty – PCT – Ordinary – PCT – Conventional – Divisional and Patent of Addition – Specifications – Provisional and complete – Forms and fees Invention in context of "prior art" – Patent databases – Searching International Databases – Country-wise patent searches (USPTO,espacenet(EPO) – PATENT Scope (WIPO) – IPO, etc National & PCT filing procedure – Time frame and cost – Status of the patent applications filed – Precautions while patenting – disclosure/non-disclosure – Financial assistance for patenting – Introduction to existing schemes Patent licensing and agreement Patent infringement – Meaning, scope, litigation, case studies

UNIT III BIOSAFETY 9

Introduction – Historical Backround – Introduction to Biological Safety Cabinets – Primary Containment for Biohazards – Biosafety Levels – Biosafety Levels of Specific Microorganisms – Recommended Biosafety Levels for Infectious Agents and Infected Animals – Biosafety guidelines – Government of India.

UNIT IV GENETICALLY MODIFIED ORGANISMS 9

Definition of GMOs & LMOs – Roles of Institutional Biosafety Committee – RCGM – GEAC etc. for GMO applications in food and agriculture – Environmental release of GMOs – Risk Analysis – Risk Assessment – Risk management and communication – Overview of National Regulations and relevant International Agreements including Cartegana Protocol.

UNIT V ENTREPRENEURSHIP DEVELOPMENT 9

Introduction – Entrepreneurship Concept – Entrepreneurship as a career – Entrepreneurial personality – Characteristics of successful Entrepreneur – Factors affecting entrepreneurial growth – Entrepreneurial Motivation – Competencies – Mobility – Entrepreneurship Development Programmes (EDP) - Launching Of Small Enterprise - Definition, Characteristics – Relationship between small and large units – Opportunities for an Entrepreneurial career – Role of small enterprise in economic development – Problems of small scale industries – Institutional finance to entrepreneurs - Institutional support to entrepreneurs.

TOTAL : 45 PERIODS

REFERENCES

1. Bouchoux, D.E., “Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets for the Paralegal”, 3rd Edition, Delmar Cengage Learning, 2008.
2. Fleming, D.O. and Hunt, D.L., “Biological Safety: Principles and Practices”, 4th Edition, American Society for Microbiology, 2006.
3. Irish, V., “Intellectual Property Rights for Engineers”, 2nd Edition, The Institution of Engineering and Technology, 2005.
4. Mueller, M.J., “Patent Law”, 3rd Edition, Wolters Kluwer Law & Business, 2009.
5. Young, T., “Genetically Modified Organisms and Biosafety: A Background Paper for Decision- Makers and Others to Assist in Consideration of GMO Issues” 1st Edition, World Conservation Union, 2004.
6. S.S Khanka, “Entrepreneurial Development”, S.Chand & Company LTD, New Delhi, 2007.

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