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

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

I.	Develop innovative automotive technologies to address specific needs of performance, comfort, safety and eco-friendliness.
II.	Apply computational tools for comprehensive understanding of the complex systems in automotive engineering.
III.	Update themselves to recent trends, technologies and industrial scenarios by pursuing lifelong learning.

2. PROGRAMME OUTCOMES (POs):

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	Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice..
5	Become familiar with modern engineering tools and analyze the problems within the domains of Automobile Engineering as the members of multidisciplinary teams.
6	Apply engineering knowledge, state-of-the-art tools and techniques to design and analyze automobile systems and sub-systems.

Note: Program may add up to three additional Pos.

4. PEO / PO Mapping:

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

Every programme objectives must be mapped with 1,2,3,-, scale against the correlation PO's

MAPPING – PG- M.E. AUTOMOBILE ENGINEERING

		COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6
YEAR I	SEMESTER I	Advanced Numerical Methods	3	1	3	1	2	2
		Automotive Chassis and Drive Line Systems	3	2	2	2	3	3
		Engine and Auxiliary Systems	2	3	2	2	3	3
		Automotive Electrical and Electronics	2	2	3	2	2	3
		Research Methodology and IPR	2	2	2	3	3	2
		Professional Elective – I	3	1	3	2	3	3
		Audit Course – I*	2	3	2	3	2	2
		Engine and Chassis Components Laboratory	2	3	2	3	2	2
		Automotive Electrical and Electronics Laboratory	2	3	2	3	2	2
	SEMESTER II	Electric and hybrid vehicles	2	1	2	1	3	3
		Automotive Engine Pollution and Control	2	1	3	1	2	3
		Dynamics of Road Vehicle	3	2	2	2	3	3
		Vehicle Body Engineering	2	2	3	2	2	3
		Professional Elective – II	3	1	3	2	3	3
		Audit Course – II*	2	3	2	3	2	2
		Engine and Vehicle Testing Laboratory	2	3	2	3	2	2
		Design and Modelling of Vehicle Components Laboratory	2	3	2	3	2	2
		Mini Project with Seminar	2	3	2	3	2	3
YEAR II	SEMESTER III	Engine Management Systems	3	2	2	2	3	3
		Professional Elective – III	3	1	3	2	3	3
		Professional Elective – IV	3	1	3	2	3	3
		Open Elective	2	3	2	3	3	3
		Project Work I	2	3	2	3	2	3
	SEMESTER IV	Project Work II	2	3	2	3	2	3

ANNA UNIVERSITY, CHENNAI
NON- AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY
M.E. AUTOMOBILE ENGINEERING
REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA AND SYLLABI
SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MA4154	Advanced Numerical Methods	FC	4	0	0	4	4
2.	AM4101	Automotive Chassis and Drive Line Systems	PCC	3	1	0	4	4
3.	AM4102	Engine and Auxiliary Systems	PCC	3	0	0	3	3
4.	AM4103	Automotive Electrical and Electronics	PCC	3	0	0	3	3
5.	RM4151	Research Methodology and IPR	RMC	2	0	0	2	2
6.		Professional Elective – I	PEC	3	0	0	3	3
7.		Audit Course – I*	AC	2	0	0	2	0
PRACTICAL								
8.	AM4111	Engine and Chassis Components Laboratory	PCC	0	0	4	4	2
9.	AM4112	Automotive Electrical and Electronics Laboratory	PCC	0	0	4	4	2
			TOTAL	**20**	**1**	**8**	**29**	**23**

* Audit Course is optional.

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	AM4201	Automotive Pollution and Control	PCC	3	0	0	3	3
2.	AM4202	Dynamics of Road Vehicles	PCC	3	0	0	3	3
3.	AM4203	Vehicle Body Engineering	PCC	3	0	0	3	3
4.	AM4204	Electric and Hybrid Vehicles	PCC	3	0	0	3	3
5.		Professional Elective – II	PEC	3	0	0	3	3
6.		Audit Course – II*	AC	2	0	0	2	0
PRACTICAL								
7.	AM4211	Engine and Vehicle Testing Laboratory	PCC	0	0	4	4	2
8.	AM4212	Design and Modelling of Vehicle Components Laboratory	PCC	0	0	4	4	2
9.	AM4213	Mini Project with Seminar	EEC	0	0	4	4	2
			TOTAL	**17**	**0**	**12**	**29**	**21**

* Audit Course is optional.

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	AM4301	Engine Management Systems	PCC	3	0	0	3	3
2.		Professional Elective – III	PEC	3	0	0	3	3
3.		Professional Elective – IV	PEC	3	0	0	3	3
4.		Open Elective	OEC	3	0	0	3	3
PRACTICAL								
5.	AM4311	Project Work I	EEC	0	0	12	12	6
			TOTAL	**12**	**0**	**12**	**24**	**18**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICAL								
1.	AM4411	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 - 74

FOUNDATION COURSES (FC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	MA4154	Advanced Numerical Methods	4	0	0	4	1

PROGRAM CORE COURSES (PCC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	AM4101	Automotive Chassis and Drive Line Systems	3	1	0	4	1
2.	AM4102	Engine and Auxiliary Systems	3	0	0	3	1
3.	AM4103	Automotive Electrical and Electronics	3	0	0	3	1
4.	AM4111	Engine and Chassis Components Laboratory	0	0	4	2	1
5.	AM4112	Automotive Electrical and Electronics Laboratory	0	0	4	2	1
6.	AM4204	Electric and hybrid vehicle	3	0	0	3	2
7.	AM4201	Automotive Pollution and Control	3	0	0	3	2
8.	AM4202	Dynamics of Road Vehicles	3	0	0	3	2
9.	AM4203	Vehicle Body Engineering	3	0	0	3	2
10.	AM4211	Engine and Vehicle Testing Laboratory	0	0	4	2	2
11.	AM4212	Design and Modelling of Vehicle Components Laboratory	0	0	4	2	2
12.	AM4301	Engine Management Systems	3	0	0	3	3
TOTAL CREDITS						**33**	

RESEARCH METHODOLOGY AND IPR COURSE (RMC)

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	RM4151	Research Methodology and IPR	2	0	0	2	1

PROFESSIONAL ELECTIVE COURSES

SEMESTER I, ELECTIVE – I

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	AM4001	Vehicle Design	PEC	3	0	0	3	3
2.	AM4002	Automotive Materials	PEC	3	0	0	3	3
3.	AM4003	Special Purpose Vehicles	PEC	3	0	0	3	3
4.	AM4004	Instrumentation and Experimental Techniques	PEC	3	0	0	3	3
5.	AM4005	Theory of Fuels and Lubricants	PEC	3	0	0	3	3
6.	AM4006	Design and Analysis of Experiments	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.	AM4007	Finite Element Methods in Automobile Engineering	PEC	3	0	0	3	3
2.	AM4008	Noise, Vibration and Harshness for Automobiles	PEC	3	0	0	3	3
3.	AM4009	Two and Three Wheelers	PEC	3	0	0	3	3
4.	AM4010	Hydrogen and Fuel Cells for Automobiles	PEC	3	0	0	3	3
5.	IC4291	Computational Fluid Dynamics	PEC	3	0	0	3	3
6.	AM4011	Engine Combustion Thermodynamics and Engine Heat Transfer	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE – III

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	AM4012	Alternative Fuels and Propulsion Systems	PEC	3	0	0	3	3
2.	AM4013	Hydraulic and Pneumatic Systems	PEC	3	0	0	3	3
3.	AM4014	IC Engine Process Modelling	PEC	3	0	0	3	3
4.	AM4015	Vehicle Control Systems	PEC	3	0	0	3	3
5.	AM4016	Vehicle Maintenance and Diagnostics	PEC	3	0	0	3	3
6.	AM4017	Intelligent Transport Systems	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE – IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	AM4018	Road Vehicle Aerodynamics	PEC	3	0	0	3	3
2.	AM4019	Production of Automotive Components	PEC	3	0	0	3	3
3.	AM4020	Thermal Management of Hybrid Systems	PEC	3	0	0	3	3
4.	AM4021	Vehicle Air Conditioning Systems	PEC	3	0	0	3	3
5.	AM4022	Automotive Safety	PEC	3	0	0	3	3
6.	AM4023	Industry 4.0 and IOT	PEC	3	0	0	3	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			L	T	P		
1	AM4213	Mini Project with Seminar	0	0	4	2	2
2	AM4311	Project Work I	0	0	12	6	3
3	AM4411	Project Work II	0	0	24	12	4

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

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.

UNITIII 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.

AM4101 AUTOMOTIVE CHASSIS AND DRIVE LINE SYSTEMS L T P C
3 1 0 4

COURSE OBJECTIVES:
- To understand the basic knowledge about various vehicle frames, front axles, steering systems and understand the conditions for true rolling motion of wheels during steering.
- To recognize the construction and working principle of drive line, final drive, differential and suspension systems
- To review the knowledge about the constructional feature of rear axle, wheels, tyres and braking systems.
- To impart knowledge on detailed concept, construction and principle of operation of various types of mechanical transmission components
- To design and select Hydrodynamic Transmission for various applications

UNIT I CLUTCH & GEAR BOX 12

Different types of clutches and requirement of transmission system – Principle, construction, torque capacity and design aspects of friction clutches – Objective of the gear box -Different types of gear boxes-Determination of gear box ratios & design of gear box for different vehicle applications – Typical problems.

UNIT II DRIVE-LINE STUDY, FRONT AXLE & REAR AXLE 12

Propeller shaft, Universal joints, Final drive – Different types, double reduction and twin speed final drives - Rear axle construction – Full floating, three quarter floating and semi-floating arrangements – Differential lock, Non-slip differential, Hotchkiss and torque tube drives – Effect of driving thrust and torque reaction, radius rods – Front axle construction, materials, constant velocity universal joint and front wheel geometry.

UNIT III STEERING, SUSPENSION, WHEELS AND BRAKING SYSTEM 12

Condition of true rolling motion of road wheels during steering- Ackermann and Davis steering – Different type of steering gear boxes and linkages – Hydraulic and Electronic power steering. Factors influencing ride comfort – Independent suspension- Rubber, pneumatic, hydro-elastic suspension, shock absorbers.

Construction of wheels and tyres – Braking torque developed by leading and trailing shoes – Disc brake theory – Factors affecting brake performance – Engine Exhaust Brake – Power brake- Regenerative braking – ABS.

UNIT IV HYDRO-DYNAMIC, HYDRO-STATIC & ELECTRIC DRIVES 12

Fluid coupling and Torque converters: Principle, construction and performance – Reduction of drag torque in fluid coupling – Converter couplings – Multi-stage and poly-phase torque converters – Construction and working principle of typical Janny hydro-static drive – Principle of early and modified Ward Leonard electrical control system – performance characteristics – advantages and limitations.

UNIT V AUTOMATIC TRANSMISSION, OVERDRIVE, HYDRAULIC CONTROL SYSTEMS AND APPLICATIONS 12

Ford-T model gear box – Wilson gear box – Cotal electromagnetic transmission, Chevrolet turboglide transmission – Powerglide transmission – Mercedes Benz automatic transmission – Hydraulic control systems of automatic transmission.

TOTAL= 60 PERIODS

COURSE OUTCOMES:

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

- Identify the different types of frame and chassis used in Automotive.
- Relate different types of drive lines,drives and braking systems used in Automotive.
- Acquire knowledge about different types of front axle,rear axles and suspension systems used in motor vehicles.
- Examine the usage of Hydrodynamic devices, hydrostatic devices, automatic transmission system
- Understand Electric drive used in road vehicles automatic transmission system.

REFERENCES

1. Heldt. P. M., Torque converters, Chilton Book Co., 1992
2. Judge. A.W., Modern Transmission systems, Chapman and Hall Ltd., 1990
3. SAE Transactions 900550 & 930910
4. Crouse. W.H., Anglin. D.L, Automotive Transmission and Power Trains construction, McGraw Hill, 1976
5. Birch, Automotive Braking Systems, Thomson Asia, 1999
6. Birch, Automotive Chassis Systems, Thomson Asia, 2000
7. Birch, Automotive Suspension and Steering Systems, Thomson Asia, 1999
8. Newton, Steeds & Garrot, The Motor vehicle, SAE - Butterworths, India, 13th edition, 2001
9. Judge A.W., Mechanism of the car, Chapman and Halls Ltd., London, 1986
10. John Peter Whitehead, Donald Bastow, Car Suspension and Handling, 4th Edition, Allied publishers limited, SAE Department, 2004
11. Automotive Transmissions Authors: Naunheimer, H., Bertsche, B., Ryborz, J., Novak, W. Springer-2011.

.

AM4102 ENGINE AND AUXILLARY SYSTEMS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To impart knowledge on engine operation and its constructional details
- Understand various subsystems involved in engine operation
- To impart knowledge to design and analyse engine operating parameters like air fuel ratio, injection parameters etc
- Understand the concept of combustion and its effects under various conditions
- To impart knowledge on recent developments on IC engines.

UNIT I ENGINE BASIC THEORY 9

Introduction - Engine types – Operating cycle - otto, diesel, dual operating cycles – Fuel air cycle and actual cycles –- Two and four stroke engines - Engine design and operating parameters - Typical performance and pollution curves for automobile engines.

UNIT II FUEL SUPPLY AND IGNITION SYSTEMS 9

Objective and theory of carburetion - carburetors, Types, Additional system and modern devices of carburetor — Calculation of air fuel ratio of carburetor - Diesel fuel injection objective and types - pumps and injectors, Introduction to Petrol Injection system - conventional ignition systems, advance mechanisms.

UNIT III AIR MOTION, COMBUSTION AND COMBUSTION CHAMBERS 9

Combustion stoichiometry- Combustion reactions- chemical equilibrium Combustion in SI and CI engines - Premixed and diffused combustion, laminar and turbulent combustion of fuels in engines. Droplet combustion. Comparison of knock in CI & SI engines. Direct and indirect injection combustion chambers for diesel combustion. Cylinder pressure data and heat release analysis.

UNIT IV ENGINE COOLING, LUBRICATING SYSTEMS AND SUPERCHARGING, TURBOCHARGING 9

Air cooling and water cooling – thermo syphon cooling, forced cooling systems. Fins and radiator - design calculation. Theory of lubrication — types of lubrication, splash lubrication system, petroil lubrication system, forced feed lubrication system. Properties of engine lubricants. Supercharger and Turbochargers. Modification of an engine for supercharging. Effect of supercharging on engine performance. Variable geometry and variable nozzle turbocharger. E-Turbocharger. Problems.

UNIT V NEW ENGINE TECHNOLOGY 9

Lean Burn engine – Different approaches to lean bum – LHR engine – Surface ignition Concept – catalytic ignition – homogenous charge compression ignition – variable valve timing – Multi Port Injection System - Gasoline Direct Injection – Common Rail Direct Injection – Recent Trends.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Students will have the basic knowledge on Automotive Engines and its various sub systems along with its functions.
- Student can able to design and solve engine related problems
- Student will have command knowledge over recent development in the area of internal combustion engines.
- Student can apply their knowledge to analyse and correlate the data with recent requirements of automobile industry
- Student to can explore new alternate fuels or energy system to run the automobile

REFERENCES:

1. J.B.Heywood, 'Internal combustion engine Fundamentals', McGraw Hill Book Co, 2017.
2. V.Ganesan, 'Internal combustion Engines', Tata McGraw Hill Book Co, Eighth Reprint, 2012.
3. Edward F.Obert, 'Internal combustion engines and air pollution' Harber and Row Publishers, 1973.
4. M.Khovakh, 'Motor Vehicle Engines', Mir Publishers, Mascow,1976
5. Heinz Helzler " Advenced Engine Technology" E. Arnold, 1995
6. W.H.Crouse and A.L.Anglin, 'Automotive Emission control', McGraw Hill Book Co, 1995.
7. G.S.Springer and A.J.Patterson, 'Engine emissions and pollutant formation', plenum press, New york, 1985.

AM4103	AUTOMOTIVE ELECTRICAL AND ELECTRONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To impart knowledge to the students in the principles of operation and constructional details of various Automotive Electrical and Electronic Systems
- To understand the need for starter batteries, starter motor and alternator in the vehicle.
- To differentiate the conventional and modern vehicle architecture and the data transfer among the different electronic control unit using different communication protocols
- To list common types of sensor and actuators used in vehicles.
- To understand dash – Board Instruments, various sensors and networking in vehicles.

UNIT I BATTERY AND STARTING SYSTEMS 9

Types of Batteries – Principle, Construction and Electrochemical action of Lead – Acid battery, Electrolyte, Efficiency, Rating, Charging, Testing and Maintenance. Starting System, Starter Motors – Characteristics, Capacity requirements. Drive Mechanisms. Starter Switches.

UNIT II CHARGING AND LIGHTING SYSTEMS 9

D.C. Generators and Alternators their Characteristics. Control cutout, Electrical, Electromechanical and electronic regulators. Regulations for charging. Wiring Requirements, Insulated and earth return system, details of head light and side light, LED lighting system, head light dazzling and preventive methods. Lighting design.

UNIT III ELECTRONIC IGNITION AND INJECTION SYSTEMS 9

Types of electronic ignition systems - variable ignition timing, distributor less ignition. Spark timing control. TBI, MPFI, GDI Systems. Engine mapping.

UNIT IV ELECTRICAL SYSTEMS 9

Warning and alarm instruments : Brake actuation warning system, traficators, flash system, oil pressure warning system, engine over heat warning system, air pressure warning system, speed warning system, door lock indicators, neutral gear indicator, horn design, permanent magnet horn, air & music horns. Wind shield wiper. window washer, instrument wiring system and electromagnetic interference suppression, wiring circuits for instruments, electronic instruments, dash board illumination.

UNIT V SENSORS, ACTUATORS AND MICROPROCESSOR IN AUTOMOBILES 9

Introduction- Basic Sensor Arrangement- Types of Sensors- Oxygen Sensor- Cranking Sensor- Position Sensor- Engine Oil Pressure Sensor- Linear and Angle Sensor- Flow Sensor- Temperature and Humidity Sensor- Gas Sensor- Speed and Acceleration Sensor- Knock Sensor- Torque Sensor- Yaw Rate Sensors- Tire Pressure Sensor- Actuators & its types-correlation between sensors- actuators-Microprocessor And Microcomputer controlled devices in automobiles such as instrument cluster, Voice warning system, Travel information system, Keyless entry system. Environmental requirements (vibration, Temperature and EMI).

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of this course the student should be able to

- Define the glossary related to vehicle electrical and electronic system
- Understand the need for starter batteries, starter motor and alternator in the vehicle.
- Differentiate the conventional and modern vehicle architecture and the data transfer among the different electronic control unit using different communication protocols
- List common types of sensor and actuators used in vehicles.
- Understand networking in vehicles.

REFERENCES:

1. Robert Bosch- 'Automotive Hand Book'' SAE- 5th Edition- 2018.
2. Judge. A.W., Modern Electrical Equipment of Automobiles, Chapman & Hall, London, 1992.
3. William B. Ribbens -Understanding Automotive Electronics, 5th edition- Butter worth Heinemann, 1998
4. Young. A.P., & Griffiths. L., Automobile Electrical Equipment, English Language Book Society & New Press, 1990.
5. Vinal. G.W., Storage Batteries, John Wiley & Sons inc., New York, 1985.
6. Crouse.W.H., Automobile Electrical Equipment, McGraw Hill Book Co Inc., New York, 1980.
7. Spreadbury.F.G., Electrical Ignition Equipment, Constable & Co Ltd., London, 1962.
8. Robert N Brady Automotive Computers and Digital Instrumentation, Prentice Hall, Eagle Wood Cliffs, New Jersey, 1988.

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.

AM4111 ENGINE AND CHASSIS COMPONENTS LABORATORY L T P C

0 0 4 2

COURSE OBJECTIVES:

- To assemble and disassemble the parts of an IC engine.
- To identify the various component of an IC engine.
- To identify the various components in transmission systems of an automobile.
- To assemble and disassemble the various components of transmission system.

LIST OF EXPERIMENTS

1. To assemble and disassemble 1000CC engine
2. To assemble and disassemble six cylinder engine
3. To assemble and disassemble V8 engine
4. To assemble and disassemble CRDI engine
5. To assemble and disassemble MPFI engine
6. To assemble and disassemble Single plate, Diaphragm Clutch.
7. To assemble and disassemble Constant mesh, Sliding mesh gear box
8. To assemble and disassemble Transfer case
9. To assemble and disassemble Differential, Rear axle
10. To assemble and disassemble Front axle.
11. To Study different chassis layouts
12. To Study braking system
13. To Study Steering system
14. To Study Suspension system

TOTAL: 60 PERIODS

COURSE OUTCOMES:

- Dismantle and Assemble the automobile chassis and Engine components
- Identify & differentiate components of SI & CI engines
- Understand working of braking, steering, clutch, transmission, Suspension systems.
- Differentiate various subsystems of two, three & Four wheeler vehicles
- Develop skills in Dismantling and assembling of chassis components.
- Correct minor repairs and trouble shoots the breakdowns.

AM4112 AUTOMOTIVE ELECTRICAL AND ELECTRONICS LABORATORY **L T P C**
0 0 4 2

COURSE OBJECTIVE:

To import the knowledge in the area of automotive electrical system and electronic system associated in modern vehicles.

LIST OF EXPERIMENTS:

1. Testing of
   a. battery
   b. starting systems
   c. charging systems
   d. ignition systems
   e. body controller systems
2. Study of a. automotive lighting system and adjustment of head lights beam
   a. major electrical components used in modern vehicles
   b. diagnostic tool used in vehicle
3. Dismantling, testing and assembling of Starter system components
4. Dismantling, testing and assembling of charging system components
5. Basic Analog Experiments like
   a. Logic gates, Adders, Flip flops
   b. Amplifier, filter,
   c. Multiplexer and De-multiplexer
6. Interfacing seven segment displays
7. Microprocessor and microcontroller programming
   a. Arithmetic and Logic operation,
   b. Code conversion,
   c. Waveform generation,
   d. Look up table
8. Interfacing ADC and DAC for Data Acquisition and Control Application
9. Interfacing Sensors for Measurements of position, displacement, velocity, force, temperature, proximity/range
10. Display, Keyboard, Stepper Motor and DC Motor interface using microcontroller.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course the students will be able to have the knowledge in

- Automotive electrical systems and electrical accessories
- Basic microprocessor / microcontroller programming
- Automotive sensor, transducer, actuator, virtual instrumentation, data acquisition
- Development of embedded systems for automobiles

AM4201 AUTOMOTIVE POLLUTION AND CONTROL L T P C
3 0 0 3

OBJECTIVES:

- To discuss the harmful effects of major pollutants on living beings and the environment
- To analyse the formation of major pollutants like UBHC, CO, NOx, particulate matter and smoke.
- To design various control techniques to reduce pollutants in combustion
- To determine the various after treatment process to minimize emissions
- To demonstrate the various devices used to measure pollutants and discuss the Emission standards followed in various nations

UNIT I EMISSIONS FROM AUTOMOBILES 5

Sources of Pollution. Various emissions from Automobiles — Formation — Effects of pollutants on environment human beings. Emission control techniques – Emission standards.

UNIT II EMISSIONS FROM SPARK IGNITION ENGINE AND ITS CONTROL 12

Emission formation in SI Engines- Carbon monoxide- Unburned hydrocarbon, NOx, Smoke —Effects of design and operating variables on emission formation – controlling of pollutants -Catalytic converters — Charcoal Canister — Positive Crank case ventilation system, Secondary air injection, thermal reactor, Laser Assisted Combustion.

UNIT III EMISSIONS FROM COMPRESSION IGNITION ENGINE AND ITS 12

Formation of White, Blue, and Black Smokes, NOx, soot, Sulphur particulate and Intermediate Compounds – Physical and Chemical delay — Significance Effect of Operating variables on Emission formation — Fumigation, EGR, HCCI, Particulate Traps, SCR — Cetane number Effect.

UNIT IV NOISE POLLUTION FROM AUTOMOBILES 8

Sources of Noise — Engine Noise, Transmission Noise, vehicle structural Noise, aerodynamics noise, Exhaust Noise. Noise reduction in Automobiles — Encapsulation technique for noise reduction — Silencer Design

UNIT V TEST PROCEDURES AND EMISSION MEASUREMENTS 8

Constant Volume Sampling I and 3 (CVSI &CVS3) Systems- Sampling Procedures — Chassis dyno - Seven mode and thirteen mode cycles for Emission Sampling — Sampling problems — Emission analyzers —NDIR, FID, Chemiluminescent, Smoke meters, Dilution Tunnel, SHED Test, Sound level meters.

TOTAL : 45 PERIODS

OUTCOMES:

By the end of this course, students will be able to

- Differentiate the various emissions formed in IC engines
- Analyze the effects of pollution on human health and environment
- Design the control techniques for minimizing emissions
- Categorize the emission norms
- Identify suitable methods to reduce the noise emissions.

REFERENCES

1. G.P.Springer and D.J.Patterson, Engine Emissions, Pollutant formation, Plenum Press,New York, 1986.
2. D.J.Patterson and N.A.Henin, ‘Emission from Combustion Engine and their control’, Anna Arbor Science Publication,1985.
3. Engine Emissions, B.P Pundir , Narosa publications 2nd edition 2017

4. V.Ganesan, 'Internal combustion Engines', Tata McGraw Hill Book Co, Eighth Reprint, 2005.
5. Crouse and Anglin, 'Automotive Emission Control', McGraw Hill company., New york 1993.
6. L.Lberanek, 'Noise Reduction', Mcgrawhill Company., New york 1993.
7. C.Duerson, 'Noise Abatment', Butterworths ltd., London1990.
8. A.Alexander, J.P.Barde, C.lomure and F.J. Langdan, 'Road traffic noise', Applied science publisher ltd., London,1987

CO – PO Mapping

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

AM4202 DYNAMICS OF ROAD VEHICLES L T P C
3 0 0 3

OBJECTIVES:

- To provide fundamental knowledge of the vibration,
- To impart knowledge on tyres
- To provide basic concepts on suspension design and function, ride modes
- To Evaluate the performance, longitudinal dynamics and control in an automobile
- To provide basic analysis on handling, cornering stability and control

UNIT I CONCEPT OF VIBRATION 9

Definitions, Modeling and Simulation, Global and Vehicle Coordinate System, Free, Forced, Undamped and Damped Vibration, Response Analysis of Single DOF, Two DOF, Multi DOF, Magnification factor, Transmissibility ratio, Base excitation. Vibration absorber, Vibration measuring instruments, Torsional vibration, Critical speed.

UNIT II TYRES 9

Tyre axis system, tyre forces and moments, tyre marking, tyre structure, hydroplaning, wheel and rim. Rolling resistance, factors affecting rolling resistance, Longitudinal and Lateral force at various slip angles, Tractive and cornering property of tire. Camber and camber trust. Performance of tire on wet surface. Ride property of tyres. Various test carried on a tyre.

UNIT III VERTICAL DYNAMICS 9

Human response to vibration, Sources of Vibration. Suspension requirements – types. State Space Representation. Design and analysis of Passive, Semiactive and Active suspension using Quarter car, Bicycle Model, Half car and full car vibrating model. Influence of suspension stiffness, suspension damping, and tire stiffness. Control law. Suspension optimization techniques. Air suspension system and their properties.

UNIT IV LONGITUDINAL DYNAMICS AND CONTROL 9

Aerodynamic forces and moments. Equation of motion. Load distribution for three-wheeler and four-wheeler. Calculation of maximum acceleration, tractive effort and reaction forces for

different drive vehicles. Power limited acceleration and traction limited acceleration. Estimation of CG location. Stability of vehicles resting on slope. Driveline dynamics. Braking and Driving torque. Prediction of Vehicle performance. ABS, stability control, Traction control.

UNIT V LATERAL DYNAMICS 9

Steering Geometry – Steady state handling characteristics. Steady state response to steering input – Yaw velocity gain, Lateral acceleration gain, curvature response gain. Testing of handling characteristics. Transient response characteristics. Directional stability. Stability of vehicle on banked road, during turn. Effect of suspension on cornering. Roll center, Roll axis.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the courses, the students can able to

- Develop physical and mathematical models of a mechanical vibrating system
- Indicate the forces and moment acting on tyres
- Identify the suspension parameters that governs ride comfort
- Evaluate the vehicle performance in longitudinal direction
- Evaluate the lateral dynamics and control in an automobile

REFERENCES:

1. Singiresu S. Rao, "Mechanical Vibrations," Fifth Edition, Prentice Hall, 2010
2. J. Y. Wong, "Theory of Ground Vehicles", Fourth Edition, Wiley-Interscience, 2008
3. Rajesh Rajamani, "Vehicle Dynamics and Control," Second edition, Springer, 2012
4. Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics," Society of Automotive Engineers Inc, 2014
5. Dean Karnopp, "Vehicle Dynamics, Stability, and Control", Second Edition, CRC Press, 2013
6. R. Nakhaie Jazar, "Vehicle Dynamics: Theory and Application", Second edition, Springer, 2013
7. Michael Blundell & Damian Harty, "The Multibody Systems Approach to Vehicle Dynamics", Elsevier Limited, 2004
8. Hans B Pacejka, "Tyre and Vehicle Dynamics," Second edition, SAE International, 2005

CO – PO Mapping

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

AM4203 VEHICLE BODY ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- To acquire knowledge on Different aspects of car body,
- To acquire knowledge on bus body and commercial vehicle bodies.
- To acquire knowledge on Role of various aerodynamic forces and moments, measuring instruments in vehicle body design.
- To acquire knowledge on Material used in body building,
- To acquire knowledge on Tools used in body repairs and command over vehicle body engineering applications.

UNIT I CAR BODY DETAILS 10

Types of Car body - Saloon, convertibles, Limousine, Estate Van, Racing and Sports car – car body terminology - Visibility- regulations, driver's visibility, improvement in visibility and tests for visibility. Driver seat design -Car body construction-Various panels in car bodies. Safety: Safety design, safety equipment for cars. AIS and SAE car body Regulations

UNIT II BUS BODY DETAILS 9

Types of bus body: based on capacity, distance travelled and based on construction.– Bus body lay out, floor height, engine location, entrance and exit location. Types of metal sections used –Constructional details: Conventional and integral. AIS and SAE bus body Regulations

UNIT III COMMERCIAL VEHICLE DETAILS 8

Types of commercial vehicle bodies - Light commercial vehicle body. Construction details of Flat platform body, Tipper body and Tanker body – Dimensions of driver's seat in relation to controls – Drivers cab design.

UNIT IV VEHICLE AERODYNAMICS 9

Objectives, Vehicle drag and types. Various types of forces and moments. Effects of forces and moments. Side wind effects on forces and moments. Various body optimization techniques for minimum drag. Wind tunnels – Principle of operation, Types. Wind tunnel testing such as: Flow visualization techniques, Airflow management test – measurement of various forces and moments by using wind tunnel balance.

UNIT V BODY MATERIALS, TRIM, MECHANISMS AND BODY REPAIR 9

Types and properties of materials used in body construction and insulation -Such as steel sheet, timber, plastics and GRP, Insulation materials. Body trim items-body mechanisms. Hand tools-power tools for body repair. Vehicle corrosion-Anticorrosion methods-Modern painting process procedure.

TOTAL : 45 PERIODS

OUTCOMES:

The students will be able to

- Discuss the different aspects of car body and its safety features.
- Categorize the various bus body based on construction and correlate its safety features.
- Categorize the construction of commercial vehicle bodies.
- Calculate the various aerodynamic forces and moments, and relate the working of measuring instruments in calculating the aerodynamic forces.
- Demonstrate the tools used in body repairs and command over the usage of material in body building.

REFERENCES:

1. Powloski, J., Vehicle Body Engineering, Business Books Ltd., 1998.
2. James E Duffy, Body Repair Technology for 4-Wheelers,Cengage Learning,2009.
3. Thomas Christian Schuetz, Aerodynamics of Road Vehicles, Fifth Edition, SAE International, 2016
4. Braithwaite, J.B., Vehicle Body building and drawing, Heinemann Educational Books Ltd., London,1997.
5. Dieler Anselm., The passenger car body, SAE International, 2000
6. Giles, G.J., Body construction and design, Illiffe Books Butterworth & Co., 1991.

CO – PO Mapping

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

AM4204 ELECTRIC AND HYBRID VEHICLES **L T P C**
3 0 0 3

OBJECTIVES:

The course should enable the students to:

1. General aspects of Electric and Hybrid Vehicles (EHV), including architectures, modeling, sizing, sub-system design and hybrid vehicle control.
2. Understand about vehicle dynamics,
3. Design the required energy storage devices,
4. Select the suitable electric propulsion systems and
5. Understand of hybrid electric vehicles.

UNIT I NEED FOR ALTERNATIVE SYSTEM **10**

Need for hybrid and electric vehicles – main components and working principles of a hybrid and electric vehicles, Different configurations of hybrid and electric vehicles .Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. Case study on specification of electric and hybrid vehicles.

UNIT II DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES **9**

Design requirement for electric vehicles- Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance- Transmission efficiency- Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refueling Systems

UNIT III ENERGY SOURCES **9**

Battery Parameters- - Different types of batteries – Lead Acid- Nickel based-Sodium based-Lithium based- Metal Air based. Battery Modeling- Equivalent circuits, Battery charging- Quick Charging devices. Fuel Cell- Fuel cell Characteristics- Fuel cell types-Half reactions of fuel cell. Ultra capacitors. Battery Management System

UNIT IV MOTORS AND CONTROLLERS 9

Types of Motors, Characteristic of DC motors, AC single phase and 3-phase motor, PM motors, Switched reluctance motors, Motor Drives and speed controllers, Torque Vectoring, Regenerative Braking. Rectifiers, Inverters, DC/DC converters.

UNIT V SUBSYTEMS OF HYBRID AND ELECTRIC VEHICLES 8

Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle - Economy of hybrid Vehicles. Steering and Suspension system. Choice of Tires.

TOTAL : 45 PERIODS

OUTCOMES:

The students will able to

- Understand working of different configurations of hybrid and electric vehicles
- Design and develop basic schemes of electric vehicles and hybrid electric vehicles.
- Choose proper energy storage systems for vehicle applications
- Choose a suitable drive scheme for developing an electric hybrid vehicle depending on resources
- Understand basic operation of power-split device in hybrid electric vehicle.

TEXT BOOKS:

1. Iqbal Husain, “Electric and Hybrid Vehicles-Design Fundamentals”, CRC Press,2003
2. Mehrdad Ehsani, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles”, CRC Press,2005.

REFERENCES:

1. James Larminie and John Lowry, “Electric Vehicle Technology Explained “John Wiley & Sons,2003
2. Lino Guzzella, “Vehicle Propulsion System” Springer Publications,2005
3. Ron HodKinson, “Light Weight Electric/ Hybrid Vehicle Design”, Butterworth Heinemann Publication,2005

CO/PO MAPPING

	Programme Outcomes					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2	1	2	1	2	2
CO2	2	2	2	1	3	3
CO3	2	1	2	1	3	3
CO4	3	1	2	1	3	3
CO5	2	1	2	1	3	3
CO Contribution (Average)	**2**	**1**	**2**	**1**	**3**	**3**

AM4211 ENGINE AND VEHICLE TESTING LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- To impart knowledge in automotive Emission measurement and methods of testing engines.
- To categorize the different measuring techniques of pollutants like UBHC, CO, NOx, CO2 and smoke.
- To Investigate the performance and combustion parameters for different engine models
- To learn removal and fitting of automotive accessories
- To understand the adjustment of play in various automobile components.

LIST OF EXPERIMENTS ON ENGINE TESTING:

1. Performance test and study on SI engine.
2. Performance test and study on diesel engine.
3. Determine the Frictional power by motoring test on petrol engines.
4. Heat balance test on Diesel engine.
5. Determination of Volumetric efficiency on diesel Engine.
6. Retardation Test On 4-Stroke, Single Cylinder Diesel Engine Test Rig
7. Morse test to determine Indicated power for multi-cylinder SI Engine

LIST OF EXPERIMENTS ON VEHICLE TESTING:

1. Tightening and adjustment of wheel bearing.
2. Adjustment of pedal play in clutch, brake, hand brake lever and steering wheel orientation.
3. Wheel alignment in four wheelers.
4. Service of transmission, braking and suspension systems.
5. Fault diagnosis and service of Electrical system like battery, starting system, charging system, lighting system.
7. Work on body and paint shop.

TOTAL: 60 PERIODS

OUTCOMES:

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

- Analysis of combustion parameters
- Differentiate the variation performance parameters of diesel engines
- Differentiate the variation performance parameters of diesel engines
- Learn removal and fitting of automotive accessories
- Understand the adjustment of play in various automobile components.

AM4212 DESIGN AND MODELLING OF VEHICLE COMPONENTS LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- To familiarize the students to use modelling software for modelling engine components
- To design chassis components with dimensions and strength requirements.
- To learn the use of standard practices in modelling of components.
- The use of modelling software to control the quality of the final engineered product.
- To visualize the complete assembly of the various system.

LIST OF ENGINE DESIGN EXPERIMENTS

1. Design and modelling of piston, piston pin and piston rings.
2. Design modelling of the connecting rod assembly.
3. Design of crankshaft, balancing weight calculations and modelling of the crankshaft assembly.
4. Design and modelling of flywheel

5. Design and modelling of the inlet and exhaust valves.
6. Design and modelling of cam and camshaft.
7. Design and modelling of combustion chamber.

LIST OF CHASSIS DESIGN EXPERIMENTS

8. Design and modelling of frame
9. Design and modelling of clutch assembly.
10. Design and modelling of constant mesh gearbox
11. Design and modelling of sliding mesh gearbox
12. Design and modelling of propeller shaft with universal joint.
13. Design and modelling of rear axle

TOTAL: 60 PERIODS

OUTCOMES:

Students will be able to

- visualize the automotive components with the help of modelling software.
- make the modifications instantly if required at the initial stage itself
- synthesize, analyse and document the design of the various components

CO – PO Mapping

Course Outcomes	Programme Outcomes					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2	3	3	3	3	2
CO2	2	3	2	3	2	3
CO3	2	2	2	3	2	2
CO4	2	3	2	2	3	2
CO5	3	3	2	3	2	2
CO Contribution (Average)	2	3	2	3	2	2

AM4301 **ENGINE MANAGEMENT SYSTEMS** **L T P C**
3 0 0 3

OBJECTIVES:

- To impart knowledge on engine management systems viz fuel injection, ignition system.
- To understand various controlling system for emission control and engine operation
- To provide opportunities to discuss the fundamentals of engine control sensors and actuators,
- To identify and analyze electric and electronic related problems
- To distinguish various engine control algorithm used during engine operation.

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. 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 cutoff. 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

OUTCOMES:

At the end of the course, the student should able to

- Explain the fundamentals, operation, function of various electronic components, control techniques in an engine management system.
- Explain the fundamentals, operation, function of various sensors and actuators in an engine management system.
- Explain the fundamentals, operation, function of various fuel injection system pertain to a SI Engine.
- Explain the fundamentals, operation, function of various fuel injection system pertain to a CI Engine.
- Explain the control algorithm during various engine operating conditions.

REFERENCES:

1. William B. Ribbens, Understanding Automotive Electronics, Butterworth-Heinemann, Eighth Edition, 2017
2. Tom Denton, Automobile Electrical and Electronic Systems, Taylor & Francis, 5th Ediition, 2018
3. Automobile Electronics by Eric Chowanietz SAE
4. Diesel Engine Management by Robert Bosch, SAE Publications, 3rd Edition, 2004
5. Gasoline Engine Management by Robert Bosch, SAE Publications, 2nd Edition, 2004

CO – PO Mapping

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

AM4001 **VEHICLE DESIGN** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand the various steps involved in the design of automotive components
- To show their knowledge in designing engine components.
- To complete design exercise and arrive at important dimensions of chassis components.
- To learn the use of standard practices in design.
- To determine the dimensions of front and rear axles

UNIT I DESIGN OF CYLINDER, PISTON AND CONNECTING ROD 10

Choice of material for cylinder and piston, design of cylinder, design of piston, piston pin, piston rings and piston assembly. Material for connecting rod, design of connecting rod assembly. Case study on design of piston for passenger car.

UNIT II DESIGN OF CRANK SHAFT AND VALVES 9

Material for crankshaft, design of crankshaft under bending and twisting. Design aspects of intake & exhaust manifolds, inlet & exhaust valves, valve springs, tappets and valve train. Design of cam & camshaft. Design of rocker arm. Cam profile generation. Case Study on design of camshaft for a four stroke IC engine.

UNIT III DESIGN OF CLUTCHES AND GEARS 10

Design of single plate clutch, multiplate clutch and cone clutch assembly. Torque capacity of clutch. Design of clutch components. Gear train calculations, layout of gearboxes. Calculation of bearing loads and selection of bearings. Design of three speed and four speed gearboxes. Case study on design of gearbox assembly for an ATV.

UNIT IV DESIGN OF VEHICLE FRAME AND SUSPENSION 6

Study of loads-moments and stresses on frame members. Design Of frame for passenger and commercial vehicle - Design of leaf Springs-Coil springs and torsion bar springs. Case study on development of frame for ATV.

UNIT V DESIGN OF FRONT AND REAR AXLE 10

Design of propeller shaft. Design details of final drive gearing. Design details of full floating, semi- floating and three quarter floating rear shafts and rear axle housings. Case study Analysis of loads-moments and stresses at different sections of front axle. Determination of optimum dimensions and proportions for steering linkages, Design of front axle beam.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to

- Analyse the stress and strain imparted on automotive components
- Compute the design and find the dimension of the vehicle components.
- Identify optimal design solutions to real-world problems in compliance with industry standards.
- Demonstrate the design skill by creating new design strategy with the application of the knowledge.
- Interpret the modern system in vehicle and would help in developing the system with less impact to the environment.

REFERENCES:

1. Khurmi. R.S. & Gupta. J.K., "A text book of Machine Design", Eurasia Publishing House (Pvt) Ltd, 2001.
2. Kolchin-Demidov , “Design of Automotive Engines”-Mir Publishers (1984)

3. Stokes , “Manual gearbox design”, Butterworth-Heinemann 1992
4. “Design Data Hand Book”, PSG College of Technology, 2013- Coimbatore.
5. Dean Averns, "Automobile Chassis Design", Illife Book Co., 2001.
6. Giancarlo Genta, Lorenzo Morello, “The Automotive Chassis Volume 1, Components Design”, Springer International Edition.2014
7. Lukin P G G and Rodionov V, “Automobile Chassis Design and Calculations”, Mir Publishers, Moscow, 1989.
8. Robert C. Juvinall and Kurt M. Marshek, “Fundamentals of Machine component Design”,6th Edition, Wiley, 2017

CO – PO Mapping

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

AM4002 AUTOMOTIVE MATERIALS L T P C
3 0 0 3

COURSE OBJECTIVES

The course should enable the students to:

- Select suitable materials for design
- Understand the concepts of heat treatment and surface modification techniques
- Gain knowledge on materials and their applications in automotive applications
- Analyze the properties of different materials used for automotive structures, engine and transmission systems.
- Gain knowledge on advanced metallic and non- metallic materials.

UNIT I INTRODUCTION 9

Elasticity-forms - Stress and strain relationship in engineering materials - Deformation mechanism - Strengthening material - Strain hardening, alloying, polyphase mixture, martensitic precipitation, dispersion, fiber and texture strengthening - iron carbon diagram.

UNIT II METALLIC MATERIALS 9

Cast irons - types, properties, structures, compositions and applications, plain carbon steels, low alloy steels and effects of alloying elements, high alloy steels, stainless steel types, castability, formability, machinability, hardenability and weldability of the material, high temperature steels and super alloys. Decorative and functional coating materials for automotive parts - Electro less Nickel, Hard Chrome, and, Zirconium Phosphate, Zinc flake, Metal oxides.

UNIT III COMPOSITES 9

Mechanics, Manufacturing and Design. Types of composites. Fiber reinforced plastics (FRP), engineering ceramics, metal matrix composites, silicon carbide, graphite, fibres of zirconia, alumina and boron nitride - metal filaments - boron filaments - glass fibres applications, nanocomposites. Piezoelectric composites.

UNIT IV ELECTRICAL AND MAGNETIC MATERIALS 9

Semiconductors materials, single crystals, soft and hard magnets, superconductors, MEMS materials, nano-materials, smart-materials, shape memory alloys. Piezoelectric materials. Piezoceramic materials, polyvinyldenefluoride, Magnetostrictive Materials. Metglasmaterials.

UNIT V RUBBER AND PLASTICS MATERIALS 9

Plastics / rubber components in automobiles – function – selection criteria. Structure – property relationship of rubber. Rubber mounts – spring design – comparison with metallic springs – shape factor and its effect. Typical mounts, compounding and manufacture. Seals for static and dynamic applications. Brake fluid / hydraulic hoses, materials and manufacture.

TOTAL: 45 PERIODS

COURSE OUTCOMES

The student will be able to:

- Understand failure mechanisms.
- Gain knowledge on different class of materials and their applications
- Understand the Selection criteria for various components and importance.
- Select proper material for Automobile applications
- Understand different materials used for sensors in a vehicle

REFERENCES

1. Ahmed Elmarakbi,"Advanced Composite Materials for Automotive Applications - Structural Integrity and Crashworthiness", John Wiley & Sons Ltd, 2014.
2. Brian Cantor, Patrick Grant, Colin Johnston, "Automotive Engineering: Lightweight, Functional, and Novel Materials", CRC Press, Taylor & Francis Group, 2006.
3. Geoffrey Davies, "Materials for Automobile Bodies", Butterworth-Heinemann, 2012
4. Hiroshi Yamagata," The Science and Technology of Materials in Automotive Engines", Woodhead Publishing, 2005
5. Smallman R. E, Bishop R. J," Modern Physical Metallurgy and Materials Engineering-Science, process, applications", Sixth Edition, Butterworth-Heinemann, 1999

CO – PO Mapping

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	2	2	3
CO2	3	2	2	2	3	2
CO3	3	1	2	2	3	3
CO4	3	1	3	1	2	3
CO5	2	1	3	2	3	3
CO Contribution (Average)	**3**	**1**	**3**	**2**	**3**	**3**

AM4003 SPECIAL PURPOSE VEHICLES L T P C
3 0 0 3

COURSE OBJECTIVES:

- To enhance the knowledge of the students about the various equipment's used in earth moving, applications.
- To understand the construction and working of the vehicle for constructional application
- To describe the working nature of farm equipment's based on their application.
- To discriminate the various industrial vehicles based on the purpose.
- To acquire the knowledge on the functioning of military vehicle.

UNIT I EARTH MOVING EQUIPMENTS 9

Construction layout, capacity, specification and applications of dumpers, articulated haulers, front-end loaders, backhoe loaders, bulldozers, scrappers, motor graders, skid steer loaders ,excavator, hydraulic shovels, bucket conveyors , surface miners – highwall Miners. Selection criteria for prime mover.

UNIT II CONSTRUCTIONAL EQUIPMENTS 10

Construction layout, capacity, specification and applications of cranes – types , Articulated Trucks ,concrete ready mixer ,trenchers , Asphalt Pavers , road reclaimers , General description, specification and functions of smooth wheeled rollers, pneumatic tired rollers, , sheep's foot rollers, vibrating compactors , draglines, drillers ,borewell machine

UNIT III FARM EQUIPMEMTS 9

Classification of tractors – Main components of tractor. Working attachment of tractors – Auxiliary equipment –- Top lifting harvesters. General description, working, specification and functions of paddy harvesting machines, Sugarcane harvesting, feller bunchers, forest machines.

UNIT IV INDUSTRIAL VEHICLE 9

General description, specification, capacity and working of fork lifts - attachment, Utility vehicles, towing vehicles, man-lift chassis, scissor lift trucks, material handlers, fire fighting vehicle, reclaimers, Street sweepers

UNIT V MILITARY AND COMBAT VEHICLES 8

Special features and constructional details of Main Battle tank, gun carriers, truck-mounted missile launchers, transport vehicles, armoured vehicle-launched bridge, amphibious bridging vehicle, and communication vehicles.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to

- Demonstrate their understanding about the operation of the various special purpose vehicle
- Understand the construction layout of earth moving equipment's.
- Have the ability to apply the knowledge to design a new concept for construction application.
- Demonstrate their skill in developing modern techniques for future farming vehicles
- Distinguish the various military vehicle and infer their particular technology.

REFERENCES:

1. Abrosimov. K. Bran berg.A. andKatayer.K., " Road making Machinery ", MIR Publishers, Moscow, 1971.
2. Jerry Scutts, "Advanced Military Vehicle Modelling" , Osprey Publishing, 1999
3. Rodichev and G.Rodicheva, Tractor and Automobiles, MIR Publishers, 1987.

4. B. Geleman and M. Moskovin, Farm tractors, MIR publishers, Moscow.
5. Kolchin,A., and V.Demidov, Design of Automotive Engines for Tractor, MIR Publishers, 1972.
6. Off the road wheeled and combined traction devices - Ashgate Publishing Co. Ltd. 1998.
7. Peurifoy R.L “Construction Planning, Equipment and Methods”, Tata McGraw-Hill, New Delhi, 2002.
8. Wong J “ Terramechanics and Off-Road Vehicle Engineering”, Butterworth-Heinemann, 2009

CO – PO Mapping

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	3	3
CO2	2	1	3	2	3	2
CO3	3	1	3	2	2	3
CO4	3	2	3	1	3	3
CO5	3	1	2	2	3	3
CO Contribution (Average)	**3**	**1**	**3**	**2**	**3**	**3**

AM4004 INSTRUMENTATION AND EXPERIMENTAL TECHNIQUES L T P C
3 0 0 3

COURSE OBJECTIVES:

- To Study the theory, construction and operation of different measurement technology for automobiles
- To understand working principle of various instruments, transducers and their application in automotive industry.
- To acquire knowledge on various mechanical measurement instruments techniques
- To study different types of instruments used for engine testing and its working principle
- To acquire knowledge in experimental methods for testing the vehicle with different instruments

UNIT I MEASUREMENT SYSTEMS 8

Static and Dynamic Measurement systems-importance of measurement system – methods of measurement -applications - characteristics of measuring system-static and dynamic characteristics of measuring system – Analysis of experimental detail, Error analysis-types of errors-limiting errors

UNIT II TRANSDUCERS, MODIFIERS AND TERMINATING DEVICES 8

Transducers for Automotive Applications – Amplifiers-Classifications and application in automobile – filters -types – Data Acquisition system - analog and digital type DAS-Indicators, Printers and display device –Signal Analyzing with example of automobile applications.

UNIT III MECHANICAL MEASUREMENT 10

Instrumentation for Measuring Weight, Force, torque , pressure, power, temperature, fluid flow and special methods , vibration piezo electric effect, rotational speed .Measuring Velocity, acceleration and angular motion with respect to automobile applications

UNIT IV ENGINE EXPERIMENTAL TECHNIQUES 10

I.S Code for Engine testing – Instrumentation for performance testing of engine, Instrumentation for Research and development, Instrumentation for noise, vibration, in cylinder gas flow, flame temperature Dynamic Cylinder pressure measurements.

UNIT V VEHICLE EXPERIMENTAL TECHNIQUES 9

Laboratory tests- test tracks - Endurance Tests- crash tests- wind tunnel tests- Dynamic cornering fatigue, dynamic radial fatigue tests – procedure, bending moment and radial load calculations. Impact test – road hazard impact test for wheel and tyre assemblies, test procedures, failure criteria and performance criteria. Bumpers - types of tests, pendulum test, fixed collision barrier test, procedure, performance criteria. Air and hydraulic brake test, air brake actuator, valves test, performance requirements.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course the student should be able to

- Understand the components of the automotive instruments and their functions and the latest developments in this field
- Understand transducers, modifiers and terminating devices
- Understand mechanical measurement
- Grasp the basics of engine experimental techniques
- Grasp the basics of vehicle experimental techniques

REFERENCES

1. J.G. Giles, 'Engine and Vehicle Testing', Illiffe books Ltd., London,1988.
2. W. Judge, 'Engineering Precision Measurement', Chapman and Hall Ltd, Essex StreetW.C.,1951,
3. Rangan, Sharma and Mani, 'Instrumentation Devices and systems', Tata McGraw Hill Publishing Co., Ltd., 1990
4. T.G. Beckwith and Buck, 'Mechanical Measurements', Oxford and IBH Publishing House, NewDelhi, 1995
5. D.Patambis, 'Principle of Industrial Instrumentation', Tata McGraw Hill Publishing Co, New Delhi,1990.

CO – PO Mapping

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

AM4005 THEORY OF FUELS AND LUBRICANTS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To identify the processes behind fuel extraction system.
- To understand the theory behind lubrication
- To study the properties of lubricants.
- To elaborate the properties of fuels used in IC engines.
- 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 basestocks, 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 Additives and additive mechanism, for lubricants. Introduction to Nano fluids

TOTAL : 45 PERIODS

OUTCOMES:

At the end of this course the student should be able to

- Identify the processes behind fuel extraction system.
- Understand the theory behind lubrication
- Study the properties of lubricants.
- Elaborate the properties of fuels used in IC engines.
- Understand the need of fuel rating.

REFERENCES

1. Ganesan. V., “Internal Combustion Engines”, Tata McGraw-Hill Publishing Co., New Delhi, 2017.
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

AM4006 DESIGN AND ANALYSIS OF EXPERIMENTS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To identify the key factors in designing experiments
- To develop appropriate experimental design
- To analyse the data to derive valid conclusions.
- To optimize process conditions by developing empirical models.
- To Design robust products and processes using parameter design approach.

UNIT I FUNDAMENTALS OF EXPERIMENTATION 9

Role of experimentation in rapid scientific progress, Historical perspective of experimental approaches, Steps in experimentation, Principles of experimentation.

UNIT II SIMPLE COMPARATIVE EXPERIMENTS 9

Basic concepts of probability and statistics, Comparison of two means and two variances, Comparison of multiple (more than two) means & ANOVA.

UNIT III EXPERIMENTAL DESIGNS 9

Factorial designs, fractional factorial designs, orthogonal arrays, standard orthogonal arrays & interaction tables, modifying the orthogonal arrays, selection of suitable orthogonal array design, analysis of experimental data.

UNIT IV RESPONSE SURFACE METHODOLOGY 9

Concept, linear model, steepest ascent, second order model, regression

UNIT V TAGUCHI'S PARAMETER DESIGN 9

Concept of robustness, noise factors, objective function & S/N ratios, inner-array and outer-array design, data analysis

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Formulate objective(s) and identify key factors in designing experiments for a given problem.
- Develop appropriate experimental design to conduct experiments for a given problem.
- Analyze experimental data to derive valid conclusions.
- Optimize process conditions by developing empirical models using experimental data.
- Design robust products and processes using parameter design approach.

REFERENCES

1. Montgomery DC, Design and Analysis of Experiments, 7th Edition, John Wiley & Sons, NY, 2008.
2. Ross PJ, Taguchi Techniques for Quality Engineering, McGraw-Hill Book Company, NY, 2008.

AM4007 FINITE ELEMENT METHODS IN AUTOMOBILE ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- To equip the students with the Finite Element Analysis fundamentals.
- To enable the students to formulate the design problems into FEA.
- To introduce basic aspects of finite element technology, including domain discretization, polynomial interpolation, application of boundary conditions
- To understand the assembly of global arrays, and solution of the resulting algebraic systems.
- Understand how to use finite element analysis in engineering problems and application areas including stress, heat transfer, and vibration analysis

UNIT I INTRODUCTION 9

Engineering design analysis-meaning and purpose, steady state, propagation and transient problems. Concepts of FDM, FEM, FVM. Steps involved in FEM. Applicability of FEM to structural analysis, heat transfer and fluid flow problems. Advantages and limitations of FEM. Test for convergence. Element choice. Commercial finite element packages. Solution of Boundary value problem - Integral formulation for numerical solution - Variational methods – Minimum total potential energy formulation.

UNIT II 1D ELEMENTS 9

Use of bar and beam elements in structural analysis. Bar Element – Stiffness matrix Formulation by direct and polynomial methods. Boundary condition and assemblage concepts. Beam element characteristics matrix. Global, local, natural coordinates.

UNIT III 2D ELEMENTS 9

Rectangular elements - Quadratic quadrilateral elements - Linear Triangular elements - 2D elements applications for plane stress, plane strain and axi-symmetric problems. Treatment of boundary condition. Mesh generation techniques. Numerical integration schemes. Iso Parametric elements. Introduction to 3D Elements.

UNIT IV STRUCTURAL AND DYNAMIC ANALYSIS 9

1D & 2D problems in Solid mechanics. Dynamics problems representation in FE. Free vibration problem formulation. Torsion of non circular shaft - axisymmetric problem. Case Studies like Structural analysis of Chassis Frame, Whirling speed of propeller shaft, contact analysis of gears, modal analysis of suspension system, impact, crash worthiness etc.

UNIT V HEAT TRANSFER ANALYSIS AND FLOW ANALYSIS 9

1D & 2D problems in fluid mechanics and heat transfer by conduction and convection. Transient thermal analysis. Case Studies like Heat transfer analysis of piston, fins.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students will be able to:

- Identify mathematical model for solution of common engineering problems.
- Formulate simple problems into finite elements.
- Solve structural, thermal, fluid flow problems.
- Use professional-level finite element software to solve engineering problems in Solid mechanics, fluid mechanics and heat transfer.
- Derive element matrix equation by different methods by applying basic laws in mechanics and integration by parts

CO – PO Mapping

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

REFERENCES

1. Segerlind,L.J., Applied Finite Element Analysis, Second Edition, John Wiley and Sons Inc.,New York, 1984
2. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, “Concepts and applications of finite element analysis”, 4th edition, John Wiley & Sons, 2007.
3. Krishnamurthy,C.S., Finite Element Analysis, Tata McGraw Hill, 1987.
4. Ramamurthi,V., Computer Aided Design in Mechanical Engineering, Tata McGraw Hill,
5. 1987.
6. Bathe,K.J. and Wilson,E.L., Numerical methods in finite element analysis, Prentice Hall of India Ltd., 1983.
7. J. N. Reddy, “Finite Element Methods”, 2nd Edition, 6th Reprint, Tata McGraw Hill, 2005.
8. Singiresu S. Rao, “The Finite Elements Methods in Engineering”, 4th Edition, USA, 2005.

AM4008 NOISE, VIBRATION AND HARSHNESS FOR AUTOMOBILES L T P C
3 0 0 3

OBJECTIVES:

The course should enable the students to:

1. To introduce source of noise and vibration
2. To broaden the understanding of sound measurement and human sensitivity
3. To underline the importance of simulation, anechoic chamber and acoustic holography
4. To broaden the importance of statistical and frequency analysis
5. To introduce active control techniques

UNIT I NVH IN THE AUTOMOTIVE INDUSTRY 9

Sources of noise and vibration. Design features. Common problems. Marque values. Noise quality. Pass-by noise requirements. Target vehicles and objective targets. Development stages in a new vehicle programme and the altering role of NVH engineers.

UNIT II SOUND AND VIBRATION THEORY 9

Sound measurement. Human sensitivity and weighting factors. Combining sound sources. Acoustical resonances. Properties of acoustic materials. Transient and steady state response of one degree of freedom system applied to vehicle systems. Transmissibility. Modes of vibration.

UNIT III TEST FACILITIES AND INSTRUMENTATION 9

Laboratory simulation: rolling roads (dynamometers), road simulators, semi-anechoic rooms, wind tunnels, etc. Transducers, signal conditioning and recording systems. Binaural head recordings. Sound Intensity technique, Acoustic Holography, Statistical Energy Analysis

UNIT IV SIGNAL PROCESSING 9

Sampling, aliasing and resolution. Statistical analysis. Frequency analysis. Campbell's plots, cascade diagrams, coherence and correlation functions.

UNIT V NVH CONTROL STRATEGIES & COMFORT 9

Source ranking. Noise path analysis. Modal analysis. Design of Experiments, Optimisation of dynamic characteristics. Vibration absorbers and Helmholtz resonators. Active control techniques.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this course the student will be able to:

1. Identify sources of noise and vibration
2. Measure sound intensity and human sensitivity
3. Carryout statistical energy analysis and simulators
4. Determine active control techniques
5. Carryout statistical and frequency analysis barrier.

REFERENCES:

1. Allan G. Piersol ,Thomas L. Paez “Harris’ shock and vibration hand book” , McGraw-Hill ,New Delhi, 2010
2. Clarence W. de Silva , “Vibration Monitoring, Testing, and Instrumentation “,CRC Press,2007
3. Colin H Hansen “Understanding Active Noise Cancellation “ , Spon Press , London .2003
4. David A.Bies and Colin H.Hansen “Engineering Noise Control: Theory and Practice “ Spon Press , London . *2009*
5. Matthew Harrison “Vehicle Refinement: Controlling Noise and Vibration in Road Vehicles “,Elsevier Butterworth-2004

CO – PO Mapping

Course Outcomes	Programme Outcomes					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3	1	2	2	3	3
CO2	2	2	3	3	2	3
CO3	3	2	3	2	3	3
CO4	3	1	2	1	3	2
CO5	3	1	3	2	3	2
CO Contribution (Average)	3	1	3	2	3	3

AM4009 **TWO AND THREE WHEELERS** **L T P C**
3 0 0 3

The objective of this course is to make the students to

- analyse various two wheelers and their dynamics
- design the power unit of two and three wheelers
- apply the design aspects of transmission system
- understand different frames and suspension system used in two wheelers.
- Emphasize the knowledge on three wheelers and its sub systems

UNIT I INTRODUCTION 9

Classifications of different two wheelers based on usage - design considerations – weight and dimension limitations –requirements, stability problems, gyroscopic effect- pendulum effect of two and three wheelers. Introduction to All-terrain vehicles.

UNIT II POWER UNITS, IGNITION SYSTEMS AND OTHER ELECTRICAL SYSTEMS 10

Two stroke and four stroke engines. Carburetors – Petrol injection on Gasoline Engines, CI engine Injection systems – Single and multi-cylinder engines – Cooling and Lubrication systems. Battery coil ignition, magneto ignition and electronic ignition. Lighting and other electrical systems of two wheelers. Design criteria for engines.

UNIT III CLUTCHES AND TRANSMISSION 10

Introduction to clutches - Types of clutches - Design of clutch, Assist slipper clutch, Gear boxes., Types of gearboxes, Gear change mechanism – Progressive Gear box. Final drives - CVT. Belt, chain and shaft drive. Freewheeling devices. Starting Mechanism in two wheelers.

UNIT IV FRAMES, SUSPENSION, WHEELS, TYRES AND BRAKES 8

Two wheeler frame – Function and Types of frames. Design of frames for fatigue strength, torsional stiffness and lateral stability. Front and rear forks of two wheelers. Springs for suspension, Dampers, Monoshock suspension in two wheeler constructional details of wheel and tyres. Braking systems of two wheelers.

UNIT V THREE WHEELERS 8

Case study on Auto rickshaw - different types, Pick-Ups and delivery type vehicles, frames and transmission in three wheelers, wheel types, wheel mountings attachment, tyre types. Brake systems.

TOTAL : 45 PERIODS

OUTCOMES

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

- Analyse various two wheelers and its technology along with its functions.
- Design power plant for different two and three wheelers.
- Design and analyse transmission units used in two wheelers.
- Analyse different frames and suspension system used in two wheelers.
- Analyse and design the frames and suspension of three wheelers.

REFERENCES:

1. Modern motor cycle technology by Edward Abdo 3rd Edition, 2015
2. Two Wheelers and Three Wheelers, By K. K. Ramalingam, Scitech publications, 2017.
3. Motorcycle handling and chassis design, By Tony Foale, 2nd Edition, 2006
4. Motorcycle Dynamics, By Vittore Cossalter 2nd Edition, 2006
5. Irving,P.E., Motor cycle Engineering, Temple Press Book, London, 1992.
6. Motorcycle Basics Tech book by Haynes 2nd Edition, 2015
7. Build Your Own Electric Motorcycle, By Carl Vogel,2009

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	-	3	3
CO2	3	3	3	-	3	3
CO3	3	3	3	-	3	3
CO4	3	3	3	-	3	3
CO5	3	3	3	-	3	3
CO Contribution (Average)	3	3	3	-	3	3

AM4010 HYDROGEN AND FUEL CELLS FOR AUTOMOBILES L T P C
3 0 0 3

OBJECTIVES:

The course should enable the students:

- To Describe the different production and storage methods of hydrogen.
- To Explain the methods related to usage of hydrogen in SI Engines.
- To Explain the methods related to usage of hydrogen in CI Engines.
- To Illustrate the technical features of fuel cells for automotive applications
- To Outline the design concepts of hydrogen fuel cell systems for road vehicles

UNIT I HYDROGEN AS FUTURE ENERGY CARRIER 9

Hydrogen Production : Thermal Processes - Electrolytic Processes - Photolytic Processes - Hydrogen Distribution - Hydrogen Storage - Hydrogen Storage in High Compressed Gas Form - Hydrogen Storage in Liquid Cryogenic Form - Hydrogen Storage in Solid Materials - Need- Properties- Pollution- Emission standards- World and Indian Scenario.

UNIT II HYDROGEN IN S.I. ENGINE SYSTEM 9

Engine Modifications- Combustion Characteristics – Dual Fueling- Direct Injection of Gaseous and Liquefied Hydrogen.

UNIT III HYDROGEN IN C.I. ENGINE SYSTEM 9

Engine Modification & Combustion Characteristics - Direct Injection – Gaseous and Liquified Hydrogen- Dual Fuel Mode- and Hydrogen Enrichment.

UNIT IV FUEL CELLS FOR AUTOMOTIVE APPLICATIONS 9

Basic Concepts of Electrochemistry - Proton Exchange Membrane Fuel Cells: Membrane-Electrocatalysts- GDL- Bipolar Plates - Sensitivity of PEM Stacks to Operating Conditions: Polarization Curve- Effect of Operative Parameters on the Polarization Curve - Durability of PEM Fuel Cells

UNIT V DESIGN OF HYDROGEN FUEL CELL SYSTEMS 9

Hydrogen Fuel Cell Systems: Preliminary Remarks - Hydrogen Feeling System - Air Feeding System - Thermal Management System - Water/Humidification Management System - Integrated Fuel Cell System: Efficiency- Dynamics- Costs.

TOTAL : 45 PERIODS

OUTCOMES

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

- Describe the different properties- production and storage methods of hydrogen.
- Explain the concept- methods and various features related to usage of hydrogen in SI Engines.
- Explain the concept- methods and various features related to usage of hydrogen in CI Engines.
- Illustrate the technical features of fuel cells for automotive applications
- Outline the design concepts of hydrogen fuel cell systems for road vehicles

REFERENCES:

1. Johannes Topler and Jochen Lehmann- Hydrogen and Fuel Cell Technologies and Market Perspectives- Springer- 2016
2. Pasquale Corbo-FortunatoMigliardini and OttorinoVeneri- Hydrogen Fuel Cells for Road Vehicles (Green Energy and Technology)- Spinger- 2011.
1. Alternative Fuels (A decade of success and Promise) edited by RedaMoh.Bata- SAE PT-48- ISBN 1-56091 – 593 – 5.
2. Osamu Hirao and Richard K. Pefley- Present and future Automotive Fuels- John Wiley and Sons- 1988.
3. Keith Owen and Trevor Eoley- Automotive Fuels Handbook- SAE Publications- 1990.
4. Richard L. Bechtold- Automotive Fuels Guide Book- SAE Publications- 1997.
5. Hydrogen Fuel Cells for Road Vehicles- April 2010- Springer

Mapping of CO and PO

Course Outcomes	Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	1	2	1	3	2
CO2	2	1	1	1	2	1
CO3	2	1	1	1	1	1
CO4	3	2	2	1	1	1
CO5	2	1	1	2	3	2
CO Contribution (Average)	**2**	**1**	**2**	**1**	**2**	**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.

AM4011 ENGINE COMBUSTION THERMODYNAMICS AND ENGINE HEAT TRANSFER **L T P C 3 0 0 3**

OBJECTIVES

1. To develop the students, understand the thermodynamic principles of general and engine combustion.
2. To acquire knowledge in chemical kinetics involved in general and engine combustion
3. To study different types of flames, their structures and analyze the factors affecting on them.
4. To demonstrate the importance of engine heat release rate and heat transfer models for engine combustion analysis.
5. To acquire knowledge in experimental methods for combustion and heat transfer calculations to apply in engines analysis.

UNIT – I INTRODUCTION TO COMBUSTION PROCESSES 9

Definition for Fuel and Oxidizer – types – Various combustion modes- Combustion in premixed laminar and premixed turbulent combustion - Flame Speed – Burning Velocity - diffusion flames – Combustion process in IC engines.

UNIT – II THERMODYNAMICS OF COMBUSTION 9

Thermodynamics of combustion – Thermodynamic Properties – Ideal gas law – Gas mixture combustion – Stoichiometric combustion – Thermochemistry – Hess's law- Adiabatic flame temperature – Physics of combustion – Fick's law of species diffusion – Conservation equations – Boundary layer concept

UNIT – III NORMAL, ABNORMAL COMBUSTION IN SI ENGINES 9

Stages of combustion – Flame propagation –– Flame Limits –Flame Extinction - Rate of pressure rise – Cycle to cycle variation – Abnormal combustion – Theories of detonation – Effect of engine operating variables on combustion –Example problems.

UNIT – IV COMBUSTION AND HEAT TRANSFER IN IC ENGINES 9

Droplet and spray combustion theory – delay period – Peak pressure – Heat release – Gas temperature – Diesel knock. Basic definitions – Convective heat transfer – Radiative heat transfer – Heat transfer, temperature distribution and thermal stresses in piston – Cylinder liner – Cylinder head – fins and valves.

UNIT – V EXPERIMENTAL INVESTIGATION OF COMBUSTION AND HEAT TRANSFER IN IC ENGINES 9

Photographic studies of combustion processes – P-θ diagrams in SI and CI engines, Assembly – Temperature measurement in piston – cylinder liner – Cylinder head and engine valves.

TOTAL 45 PERIODS

OUTCOMES:

1. Upon completion the students summarize the thermodynamic principles of general and engine combustion.
2. They understand the principle of engine combustion and the various heat transfer models and measuring methods of engine heat transfer in detail
3. They will have comment over on different flames and their importance in combustion applications
4. They will understand thermodynamics of combustion, grasp the knowledge of normal, abnormal combustion and heat transfer in engines
5. They also understand and apply the experimental techniques in investigating the combustion and heat transfer processes in IC engines

CO – PO Mapping

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

REFERENCES:

1. John. B. Heywood,' Internal Combustion Engines'", McGraw Hill Co., Newyork, 2017.
2. Spalding.D.B., "Some fundamental of Combustion", Butterworth Science Publications, London, 1985.
3. Taylor. E.F. "The Internal Combustion Engines ", International Text Book Co., Pennsylvania, 1982.
4. V.Ganesan, 'Internal combustion Engines', Tata McGraw Hill Book Co, Eighth Reprint, 2012.
5. Ashley Campbel, "Thermodynamic analysis of combustion engine", John book company, New york, 1979.

AM4012 ALTERNATIVE FUELS AND PROPULSION SYSTEMS L T P C
3 0 0 3

OBJECTIVES

- To acquire knowledge on availability of renewable fuels in the world and the technologies used for biofuel production
- To understand the challenges and difficulties involved in using alternative fuels in internal combustion engines
- To acquire complete knowledge on availability of possible alternate fuels and their properties to use as fuel in CI and SI engines
- To explore the possible methods of using all the renewable fuels in SI and CI engines and analyze the engines behavior with different fuels and methods
- To develop a complete understanding of changing the engine system, modifying the fuel for efficient use in engines

UNIT I ALTERNATIVE FUELS, PROPERTIES AND PRODUCTION METHODS OF FUELS 9

Need for alternative fuels. World and Indian energy scenario on alternative fuels. Production technologies for biofuels for internal combustion engines- Pyrolysis, gasification, digestion.

UNIT II ALCOHOLS 9

Alcohols as fuels. Production methods of alcohols. Properties of alcohols as fuels. Methods of using alcohols in CI and SI engines. Blending, dual fuel operation, surface ignition and oxygenated additives. Performance emission and combustion characteristics in CI and SI engines.

UNIT III VEGETABLE OILS 9

Various vegetable oils and their important properties. Different methods of using vegetable oils engines – Blending, preheating Transesterification and emulsification of Vegetable oils - Performance in engines – Performance, Emission and Combustion Characteristics in diesel engines. Role of Nano fluids, additives and cetane improvers for performance improvement of vegetable oils as fuel.

UNIT IV HYDROGEN 9

Production methods of hydrogen. Combustive properties of hydrogen. Problems associated with hydrogen as fuel and solutions. Different methods of using hydrogen in SI and CI engines. Performance, emission and combustion analysis in engines. Hydrogen storage - safety aspects of hydrogen.

UNIT V BIOGAS, LPG AND NATURAL GAS 9

Production methods of Biogas, Natural gas and LPG. Properties studies. CO_2 and H_2S scrubbing in Biogas., Modification required to use in SI and CI Engines- Performance and emission characteristics of Biogas, NG and LPG in SI and CI engines.

TOTAL 45 PERIODS

OUTCOMES

- Upon completion the course the students will have the complete knowledge on possible bio fuel production methods and their properties in detail.
- They will be able to apply their knowledge in making changes in engine design and fuel modification for the utilizing liquid alternative fuels effectively in the engines.
- They will be able to demonstrate the engines operation with new fuels and methods
- They further will innovate methods and design changes for optimal use of liquid alternative fuels in conventional engines
- They will be able to apply knowledge in using all the renewable gaseous fuels in IC engines with superior engine operation.

REFERENCES

1. Richard L Bechtold P.E., Alternative Fuels Guide book, Society of Automotive Engineers, 1997 ISBN 0-76-80-0052-1.
2. Donald Klass, Biomass for Renewable Energy, Fuels, and Chemicals, 1998, Academic Press, ISBN: 978-0-12-410950-6.
3. Ayhan Demirbas, ' Biodiesel A Realistic Fuel Alternative for Diesel Engines', Springer-Verlag London Limited 2008,ISBN-13: 9781846289941
4. Gerhard Knothe, Jon Van Gerpen, Jargon Krahl, The Biodiesel Handbook, AOCS Press Champaign, Illinois 2005.
5. Technical papers of SAE on Biofuels (Alcohols, vegetable oils, CNG, LPG, Hydrogen, Biogas etc.).
6. Science direct Journals (Biomass & Bio energy, Fuels, Energy, Energy conversion Management, Hydrogen Energy, etc.) on biofuels.

CO – PO Mapping

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

AM4013 HYDRAULIC AND PNEUMATIC SYSTEMS L T P C
3 0 0 3

OBJECTIVES:

- To understand the basics of hydraulic and pneumatic systems
- To examine the working of hydraulic power drives
- To apply knowledge on fluid power elements
- To design hydraulic and pneumatic systems.
- To evaluate the concept of programming in PLC circuits.

UNIT I INTRODUCTION 9

Introduction to Fluid Power – History of Fluid Power -Properties - hydraulic fluids and air. Hydraulic fluids, types, factors affecting oil performance, governing principles and laws-Brahma Press- distribution of fluid power- selection, power unit. Selection of pipe /tubing, couplings. Packing and seals, packing standards. Comparison between pneumatic and hydraulic system. energy losses in hydraulic systems- Symbols of pneumatic and hydraulic elements.

UNIT II PNEUMATIC SYSTEMS 9

Basic requirement. Elements of pneumatics, preparation of compressed air. cooling and drying of compressed air. conditioning and distribution of compressed air. pneumatics actuators constructional details of air compressors, types, Air motors, control valves, actuators and mountings, filter, lubricator, regulator. General approach of system design, travel step diagram.Types – sequence control, cascade, step counter method. K.V.Mapping and minimization of logic equation.- Simple circuits.

UNIT III HYDRAULIC SYSTEMS 9

Cylinder,Pumps Gear , vane , piston type and motors - types, characteristics., construction details. Valves for control of direction, flow and pressure – types and construction details. Power pack– elements and design. Pipes- material, pipe fittings. seals and packing. accessories used in fluid power systems - Accumulators Maintenance of hydraulic systems. Selection criteria for cylinders, valves, pipes.

UNIT IV SERVO AND PLC SYSTEMS 9

Electro pneumatics, ladder diagram for Basic Logic gates Servo and Proportional valves - types, operation, application. Hydro-Mechanical servo systems. PLC-construction, types, operation, programming.Comparison of PLC system over Relay Logic .

UNIT V AUTOMOTIVE APPLICATIONS 9

Hydraulic tipping mechanism, power steering, fort lift hydraulic gear, hydro-pneumatic suspension, air brake, Fluid Coupling and Torque converter Maintenance and trouble shooting. Design and analysis of a hydraulic /Pneumatic system-Case Study

TOTAL : 45 PERIODS

OUTCOMES:

- Understand the basics of hydraulic and pneumatic systems
- Examine the working of hydraulic power drives
- Apply knowledge on fluid power elements
- Design hydraulic and pneumatic systems.
- Evaluate the concept of programming in PLC circuits.

REFERENCES:

1. Anthony Espisito, " Fluid Power with Application", Pearson Education (Singapore) Pte.Ltd, Delhi, India, Fifth Edition, First Indian Reprint, 2003
2. Werner Deppert and Kurt Stoll, "Pneumatic Controls : An introduction to principles", Vogel-Druck Wurzburg, Germany, 1975
3. Pippenger, J.J, "Industrial Hydraulic & Pneumatics", McGraw Hill, 2002.
4. Majumdar, S.R., "Oil Hydraulic Systems: Principles and Maintenance", Tata McGraw- Hill Publishing Company Ltd., New Delhi, Fourth Reprint, 2003.
5. Peter Rohner, "Fluid Power Logic Circuit Design – Analysis, Design Method and Worked Examples", The Macmillan Press Ltd., UK, 1979.
6. Andrew Parr, "Hydraulic and Pneumatics", Jaico publishing house, 1999.

AM4014 IC ENGINE PROCESS MODELING L T P C

3 0 0 3

OBJECTIVES

1. To impart knowledge in modeling the Internal combustion engine processes and acquire knowledge in different types of engine models and their importance
2. To understand the calculation of heat of reaction, air fuel ratio and flame temperature for developing a thermodynamic engine model.
3. To acquire knowledge on the detailed concept of air standard, fuel air cycle, progressive and actual cycle simulation of SI engine.
4. To understand the gas exchange process and develop models for the intake and exhaust processes.
5. To develop a complete theoretical engine model for the SI engine and differentiate the model from CI engine model.

UNIT I INTRODUCTION TO SIMULATION 9

Introduction to Simulation, Advantages of computer simulation, Classification of engine models. Intake and exhaust flow models – Quasi steady flow -Filling and emptying -Gas dynamic Models. Thermodynamic based in cylinder models. Step by step approach in SI engine simulation. Overview of modeling softwares.

UNIT II STOICHIOMETRY AND ADIABATIC FLAME TEMPERATURE 9

Reactive processes, Heat of reaction, measurement of URP, measurement of HRP. Introduction - combustion equation for hydrocarbon fuels. Calculation of minimum air, excess air and stoichiometric air required for combustion. Introduction, complete combustion in C-H-N-O systems, constant volume adiabatic combustion, constant pressure adiabatic combustion, calculation of adiabatic flame temperature, isentropic changes of state.

UNIT III SI ENGINE SIMULATION 9

SI Engine simulation with air as working medium, deviation between actual and ideal cycle. Fuel air cycle analysis - Temperature drop due to fuel vaporization, full throttle operation, work output and efficiency calculation, part-throttle operation, engine performance at part throttle, super charged operation. SI Engines simulation with progressive combustion. Models for mass burnt fraction.

UNIT IV SI ENGINE SIMULATION WITH GAS EXCHANGE PROCESS 9

Introduction, gas exchange process, Heat transfer process, friction calculations, comparison of simulated values, validation of the computer code, engine performance simulation, pressure crank angle diagram, brake power, brake thermal efficiency, effect of speed on performance and analysis of the data.

UNIT V ENGINE SIMULATION FOR CI AND ADVANCED ENGINES 9

Zero, one and multizone models for diesel engine combustion. Wiebe's Model, Whitehouse model and Watson model for diesel combustion. Heat release rate and heat transfer models. Equilibrium calculations. Engine modeling for dual fuel engine- Multifuel engines. Programming of the modeling process and validation of the models. Parametric studies on simulated engine performance.

TOTAL: 45 PERIODS

OUTCOMES

1. Students will understand the classifications and applications of engine cycle simulation model and grasp the major modeling and simulation methods and the influence of model parameters on engine performance.
2. They will be able to calculate the heat of reaction, fuel air ratio and flame temperature for developing a thermodynamic engine model
3. They will acquire knowledge on the detailed concept of air standard, fuel air cycle, progressive and actual cycle simulation of SI engine.
4. Students will become familiar with the modeling of progressive combustion and gas exchange processes and ability to build up control-oriented simulation model of internal combustion engines
5. They will get familiarized with the essential models of engine cycle simulation and theoretical knowledge to control the calculation accuracy and calculation efficiency of engine performance, combustion and emission.

REFERENCES

1. Ashley Campbel, "Thermodynamic analysis of combustion engines", John Wiley & Sons, New York, 1986.
2. Benson.R.S., Whitehouse.N.D., "Internal Combustion Engines", Pergamon Press, oxford, 1979
3. Ganesan.V. "Computer Simulation of spark ignition engine process", Universities Press (I) Ltd, Hyderbad, 1996.

4. John. B. Heywood, 'Internal Combustion Engines'", Tata McGraw Hill Co., Newyork, 2017.
5. Ramoss.A.L., "Modelling of Internal Combustion Engines Processes", McGraw Hill Publishing Co., 1992.

CO – PO Mapping

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

AM4015 VEHICLE CONTROL SYSTEMS L T P C
3 0 0 3

OBJECTIVES

- To understand the basics of control system used in automobiles
- To recognize the electronically controlled system used in driving mechanics.
- To understand the working principle of driver modelling and power train control systems.
- To identify the control system used in hybrid and electrical vehicles.
- To illustrate the need of automated transport systems

UNIT I INTRODUCTION 9

Components of chassis management system – role of various sensors and actuators pertaining to chassis system – construction – working principle of wheel speed sensor, steering position, tyre pressure, brake pressure, steering torque, fuel level, Engine and vehicle design data.

UNIT II DRIVELINE CONTROL SYSTEM 9

Speed control – cylinder cut - off technology, Gear shifting control – Traction / braking control, brake-by-wire – Adaptive cruise control, throttle by wire. Steering - power steering, collapsible and tiltable steering column – steer by wire.

UNIT III SAFETY AND SECURITY SYSTEM 9

Airbags, seat belt tightening system, collision warning systems, child Lock, anti lock braking systems, Vision enhancement, road recognition system, Anti theft technologies, smart card system, number plate coding, central locking system.

UNIT IV COMFORT SYSTEM 9

Active suspension systems, requirement and characteristics, different types, Vehicle Handling and Ride characteristics of road vehicle, pitch, yaw, bounce control, power windows, thermal management system, adaptive noise control.

UNIT V INTELLIGENT TRANSPORTATION SYSTEM 9

Traffic routing system - Automated highway systems - Lane warning system – Driver Information System, driver assistance systems - Data communication within the car, Driver conditioning warning - Route Guidance and Navigation Systems – vision enhancement system - In-Vehicle Computing –Vehicle Diagnostics system – Hybrid / Electric and Future Cars – Case studies

TOTAL: 45 PERIODS

OUTCOMES:

- Understand the basics of control system used in automobiles
- Recognize the electronically controlled system used in driving mechanics.
- Understand the working principle of driver modelling and power train control systems.
- Identify the control system used in hybrid and electrical vehicles.
- Illustrate the need of automated transport systems.

REFERENCES:

1. U. Kiencke, and L. Nielsen,Automotive Control Systems,SAE and Springer-Verlag, 2000.
2. Ljubo Vlacic, Michel Parent, Fumio Harashima, "Intelligent Vehicle Technologies", Butterworth-Heinemann publications, Oxford, 2001.
3. Crouse, W.H. & Anglin, D.L., "Automotive Mechanics", Intl. Student edition, 9th edition, TMH, New Delhi, 2002.
4. William B.Ribbens -Understanding Automotive Electronics, 5th edition, Butter worth Heinemann Woburn, 1998.
5. Bosch, "Automotive Handbook", 6th edition, SAE, 2004.

AM4016 VEHICLE MAINTENANCE AND DIAGNOSTICS L T P C
3 0 0 3

OBJECTIVES:

To import knowledge on

- To give knowledge on the importance of vehicle maintenance
- To impart knowledge on sub systems of engine and chassis and its maintenance
- To understand different transmission systems and its maintenance
- To understand vehicle body structure and its maintenance
- To understand the function of various electrical and electronic units and its maintenance

UNIT I MAINTENANCE RECORDS, BASIC TOOLS AND INSTRUMENTS 9

Importance of maintenance. Need for Vehicle maintenance. Types of maintenance : Schedule and unscheduled maintenance. Equipment Vehicle downtime. Vehicle inspection. Workshop organization chart, Log books. Trip sheet. Lay out and requirements of maintenance shop. Standard and special tools for vehicle servicing. Standard tool set, torque wrenches, compression and vacuum gauges, OBD Tool, gauges for engine tune up.

UNIT II POWER PLANT REPAIR AND OVERHAULING 9

Dismantling of power plant and its components. Cleaning methods. Inspection and checking. Repair and reconditioning methods for all engine components. Maintenance of ignition system, fuel injection system, cooling system, lubrication system. Power plant trouble shooting chart.

UNIT III MAINTENANCE, REPAIR AND OVERHAULING OF THE CHASSIS 9

Maintenance, servicing and repair of clutch, gearbox, propeller shaft. Maintenance of front axle, rear axle, brakes, steering systems. Tyre maintenance.

UNIT IV MAINTENANCE AND REPAIR OF VEHICLE BODY 9

Body panel tools for repairing. Tinkering and painting. Minor and major repairs. Door lock and window glass actuating system maintenance.

UNIT V MAINTENANCE AND REPAIR OF ELECTRICAL AND ELECTRONIC SYSTEMS 9

Maintenance, testing and trouble shooting of battery, starter motor, dynamo, alternator, regulator, lighting system, horn and dash board instruments. Introduction to OBD.

TOTAL : 45 PERIODS

OUTCOMES:

Upon the completion of the course student can able to understand

- The importance of maintenance
- Various sub systems of vehicle and its maintenance Understand Transmission
- Functions of transmission and its maintenance
- The importance of vehicle body structure
- Basic functional principle of electrical and electronic gadgets in automobile and its maintenance

CO – PO Mapping

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

REFERENCES:

1. A.W.Judge, Motor Vehicle Servicing, 3rd Edition, Pitman Paperpack, London , 1969.
2. W.Crouse, Everyday Automobile repair, Intl.student edition, TMH, New Delhi, 1986.
3. Ernest Venk., Edward spicer, Automotive maintenance and trouble shooting, D.B.
4. Taraporevala Sons, Bombay, 1963
5. Stator Abbey, Automotive steering, braking and suspension overhaul, pitman publishing,London, 1971.
6. Frazee, fledell, Spicer,-Automobile collision Work, American technical publications, Chicago, 1953.
7. A,W.Judge, Maintenance of high speed diesel engines, Chapman Hall Ltd., London, 1956.
8. V.L.Maleev, Diesel Engine operation and maintenance, McGraw Hill Book CO., New york,1995.

AM4017 INTELLIGENT TRANSPORT SYSTEMS L T P C
3 0 0 3

OBJECTIVES:

To import knowledge on

- To describe the digital map database module
- To describe the working of the positioning module.
- To describe the working of the direction module
- To describe the working of wireless communication module.
- To describe the working of autonomous location and navigation module.

UNIT I DIGITAL MAP DATABASE MODULE 9

Introduction to Modern Vehicle Location and Navigation - Basic Representations - Reference Coordinate Systems – Standards - Proprietary Digital Map Databases - Digital Map Compilation..

UNIT II POSITIONING MODULE 9

Introduction-Dead Reckoning-Global Positioning System - Sensor fusion - Conventional map matching - Fuzzy logic Based Map matching - Other Map matching algorithms - Map aided Sensor calibration.

UNIT III DIRECTION MODULE 9

Shortest Path - Heuristic Search - Bidirectional Search - Hierarchical search - other algorithms - Guidance while En Route - Guidance while off Route - Guidance with dynamic information..

UNIT IV WIRELESS COMMUNICATION MODULE 9

Introduction - Communication Subsystem Attributes - Existing Communication Technologies - Communication Subsystem Integration.

UNIT V AUTONOMOUS LOCATION AND NAVIGATION 9

Introduction – Vehicle Location: Standalone Technologies - Radio Technologies - Satellite Technologies - Vehicle Navigation: Coping with complex requirements - Dual use navigation and entertainment components - Centralized location and Navigation Introduction - Automatic Vehicle Location: Centralized and Distributed Approach- Dynamic Navigation :Centralized and Distributed..

TOTAL : 45 PERIODS

OUTCOMES:

Upon the completion of the course student can able to understand

- the digital map database module
- the working of the positioning module.
- the working of the direction module
- the working of wireless communication module.
- the working of autonomous location and navigation module

REFERENCES:

1. "Intelligent Vehicle Technologies Theory and Applications"– L Vlacic- M Parent- F Harashima- Butterworth Heinemann
2. "Vehicle location and Navigation Systems" – Yilin Zhao – Artech House Inc.
3. Sussman Joseph- "Perspectives on Intelligent Transportation Systems (ITS)"- New York- NY: Springer- 2010.
4. Mashrur A. Chowdhury- and Adel Sadek- "Fundamentals of Intelligent Transportation Systems Planning"- Artech House- Inc.- 2003..

CO – PO Mapping

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

AM4018	ROAD VEHICLE AERODYNAMICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

To import knowledge on

- To understand the forces & moments influencing drag
- To solve exercises related to fuel economy & drag.
- To appraise upon the techniques of shape based optimization practiced in industry
- To identify the influence of rider position in motorcycle aerodynamics.
- To understand fundamentals of Experimental testing

UNIT I SCOPE OF ROAD VEHICLE AERODYNAMICS 9

Introduction, Properties of Incompressible Fluids, External Flow Phenomena Related to Vehicles, Aerodynamic Forces and Moments, Resistances to Vehicle Motion, Performance, Fuel Consumption and Fuel Economy, Strategy for Lowest Fuel Consumption.

UNIT II AIR RESISTANCE ON PASSENGER CARS 9

Car as a Bluff Body, Drag and Lift, Drag Fractions and Their Local Origins - Front End, Windshield and A-Pillar, Roof, Rear End, Plan View and Side Panels, Underbody, Wheels and Wheel Housings, Front Spoiler, Rear Spoiler. Strategies for Body Shape Development – Objectives, Detail Optimization, Shape Optimization, Facelift, Spoilers.

UNIT III AERODYNAMIC DRAG ON COMMERCIAL VEHICLES 9

Relation between Tractive Resistance, Drag Reduction and Fuel Consumption, Aerodynamic Drag Coefficients of Various Commercial Vehicles, Drag Minimization on Trucks, Buses. Add-on devices for drag reduction. Reduction of Vehicle Soiling, Water accumulation on windshield and windows.

UNIT IV MOTORCYCLE AERODYNAMICS 9

Development of Motorcycle Aerodynamics, Riding Dynamics and its Relationship with Aerodynamics, Methods of Measurement in Road Tests, Rider Influences - Rider and Pillion Passenger, Clothing and Helmets. Case Studies on racing models.

UNIT V WIND TUNNELS, MEASUREMENT AND TEST TECHNIQUES 9

Fundamentals of Wind Tunnel Technique, Tests with Reduced-Scale Models - Details of Model Construction and Test Technique, Reynolds Number Effects, Climatic Tunnels. Measuring Equipment and Transducers – Flow visualization techniques, Measurement of Aerodynamic Forces and Moments, Pressure Measurements, Measurement of the Airflow Velocity, Temperature Measurement.

TOTAL: 45 PERIODS

OUTCOMES

Upon completion of this course the students should be able to

1. Understand the forces & moments influencing drag.
2. Solve exercises related to fuel economy & drag.
3. Appraise upon the techniques of shape based optimization practiced in industry.
4. Identify the influence of rider position in motorcycle aerodynamics.
5. Expose to fundamentals of Experimental testing.

REFERENCES:

1. Hucho. W.H. – “Aerodynamic of Road Vehicles – From Fluid Mechanics to Vehicle Engineering” , Society of Automotive Engineers, U.S, Fourth edition.
2. R.H.Barnard - “Road vehicle aerodynamic design, An Introduction” , Mechaero publications, Third edition, 2010

3. T. Yomi Obidi - "Theory and Applications of Aerodynamics for Ground Vehicles" , SAE International, 2014
4. Alan Pope, Jewel B. Barlow, William H. Rae "Low speed wind tunnel testing" , John Wiley & Sons, Third edition, 1998

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	-	3	3
CO2	3	3	3	-	3	3
CO3	3	3	3	-	3	3
CO4	3	3	3	-	3	3
CO5	3	3	3	-	3	3

AM4019 PRODUCTION OF AUTOMOTIVE COMPONENTS L T P C
3 0 0 3

OBJECTIVES:

To import knowledge on

- To compare and analyse the different casting process
- To design various machining process according to the requirement
- Analysis of suitable process related to forming
- To differentiate the effect of powder metallurgy on selective components
- To impart knowledge on recent trends of automotive components

UNIT I CASTING 10

Sand casting of cylinder block and liners - Centrifugal casting of flywheel, piston rings, bearing bushes, and liners, permanent mould casting of piston, pressure die casting of carburetor other small auto parts. Machining of connecting rods - crank shafts - cam shafts - pistons - piston pins - piston rings - valves - front and rear axle housings - fly wheel - Honing of cylinder bores – Copy turning and profile grinding machines. Melting practice of alloys.

UNIT II MACHINING 9

Special consideration of machining of various components such as flywheel, piston rings, bearing bushes, and liners, permanent mould casting of piston

UNIT III FORGING AND EXTRUSION PROCESS 10

Forging materials - process flow chart, forging of valves, connecting rod, crank shaft, cam shaft, propeller shaft, transmission gear blanks, steering column. Extrusions: Basic process steps, extrusion of transmission shaft, housing spindle, steering worm blanks, piston pin and valve tappets. Hydro forming - Process, hydro forming of manifold and comparison with conventional methods- Hydro forming of tail lamp housing – forming of wheel disc and rims. Stretch forming - Process, stretch forming of auto body panels –Super plastic alloys for auto body panels.

UNIT IV POWDER METALLURGY AND PROCESSING OF PLASTICS 6

Powder metallurgy process, process variables, Manufacture of friction lining materials for clutches and brakes – plastics-raw material –automobile components – molding – injection, compression and blow – PU foam molding - Machining of plastics.

UNIT V RECENT TRENDS IN MANUFACTURING OF AUTO COMPONENTS 10

Powder injection molding - Production of aluminum MMC liners for engine blocks - Plasma spray coated engine blocks and valves - Recent developments in auto body panel forming – Squeeze Casting of pistons - aluminum composite brake rotors. Sinter diffusion bonded idler sprocket – gas injection molding of window channel – cast con process for auto parts.

TOTAL: 45 PERIODS

OUTCOMES:

By the end of this course, students will be able to

- Identify the methods to manufacture the vehicle components
- Analyze the requirements of each component and material
- Differentiate between the casting and forming process
- Design the process for manufacturing vehicle components
- Understand the advanced techniques used for manufacturing Automobile components

REFERENCES

1. Heldt. P.M., " High Speed Combustion Engines ", Oxford Publishing Co., New York, 1990.
2. Haslehurst.S.E., " Manufacturing Technology ", ELBS, London, 1990.
3. Rusinoff, " Forging and Forming of metals ", D.B. Taraporevala Son & Co. Pvt Ltd.,
4. Mumbai, 1995.
5. Sabroff.A.M. & Others, "Forging Materials & Processes ", Reinhold Book Corporation, New York, 1988.
6. Upton, "Pressure Die Casting ", Pergamon Press, 1985.
7. High Velocity "Forming of Metals ", ASTME, prentice Hall of India (P) Ltd., New Delhi, 1990
8. HMT handbook

AM4020 THERMAL MANAGEMENT OF HYBRID SYSTEMS L T P C

3 0 0 3

OBJECTIVES:

The course should enable the students:

- To understand the concepts of fluid mechanics and heat transfer
- To Design concepts for Heat Extraction in Motors
- To identify the thermal magangement of battery systems and power electronics
- To apply the concepts of thermal management in various automotive systems.

UNIT I REVIEW OF THERMODYNAMICS, FLUID MECHANICS, AND HEAT TRANSFER 9

First Law of Thermodynamics for open and closed systems; internal energy, enthalpy, and specific heat - Second Law of Thermodynamics for closed systems; Tds equations, Gibbs function - Fluid mechanics: laminar vs. turbulent flow, internal flow relationships, Navier Stokes equations - Heat transfer: simple conduction, convection, and radiation relationships; Nusselt number relationships for convective heat transfer; energy equation.

UNIT II THERMAL MANAGEMENT OF MOTORS 9

Motor Sizing vs Heat Generation - Operational Temperature Limitations of Electrical Insulation - Design concepts for Heat Extraction in Motors for xEV systems - Modelling and simulation of heat transfer in motors - Rendering of Heat extraction solutions - Sensors and Protection solutions.

UNIT III THERMAL MANAGEMENT FOR BATTERIES 9

Thermal control in vehicular battery systems: battery performance degradation at low and high temperatures - Passive, active, liquid, air thermal control system configurations for HEV and EV applications - Battery Heat Transfer

UNIT IV THERMAL MANAGEMENT FOR POWER ELECTRONICS 9

Introduction to battery modeling: tracking current demand, voltage, and State of Charge as functions of time for given drive cycles - Development of thermodynamic relationships for cell heat generation - Lumped cell and pack models for transient temperature response to drive cycles - Model parametric study results

UNIT V THERMAL MANAGEMENT SYSTEMS 9

Overall energy balance to determine required flowrates - Determination of convection and friction coefficients for air and liquid systems in various geometric configurations: flow around cylinders, flow between plates, flow through channels - Development of a complete thermal system model and parametric study results - Temperature control and heat transfer using phase change materials - Thermal Management of Power Electronics.

TOTAL: 45 PERIODS

OUTCOMES:

The students should be able to:

- Understand the concepts of fluid mechanics and heat transfer
- Design concepts for Heat Extraction in Motors
- Identify the thermal magangement of battery systems and power electronics
- Apply the concepts of thermal management in various automotive systems.

REFERENCES:

1. Nag.P.K, “Engineering Thermodynamics”, 5th Edition, Tata McGraw Hill Education, New Delhi, 2013.
2. Jerry Sergent, Al Krum, “Thermal Management Handbook: For Electronic Assemblies Hardcover”, 1998, Mc Graw- Hill.
3. “ Vehicle thermal Management Systems Conference Proceedings”, 1st Edition; 2013, Coventry Techno centre, UK
4. Younes Shabany,” Heat Transfer: Thermal Management of Electronics Hardcover” 2010 , CRC Press.
5. T. Yomi Obidi, “Thermal Management in Automotive applications”, 2015, SAE International.

AM4021 VEHICLE AIR CONDITIONING SYSTEMS L T P C

3 0 0 3

OBJECTIVES

- To impart the knowledge on automotive air-conditioning and its components functions
- To understand the Psychometric concepts, refrigerant characteristics,
- To understand the range of techniques that can be used in diagnosing
- To identify faults which affect automotive air-conditioning system performance
- To provide adequate knowledge in safe working practice. understanding the correct procedures for A/C service and repair

UNIT I FUNDAMENTALS 9

Terminology, design factors and concepts related to air conditioning system – Construction and Working principles of Thermostatic Expansion valve and Orifice tube based system- Heating system types -detailed study of HVAC components like compressor, evaporator, condenser, TXV, orifice tube, Receiver-drier, heater core etc. Location of air conditioning components in a vehicle.

UNIT II REFRIGERANTS & AIR MANAGEMENT SYSTEMS 9

Refrigerants: Temperature and pressure relation, Properties of R-12 and R134a- refrigerant oil. Simple problems -Containers - Handling refrigerants - Tapping into the refrigerant container - Ozone Layer Depletion. Air management system: Air routing for manual, semi and automatic system- cases and ducts- Air distribution, control head and doors- Defrost system

UNIT III AUTOMATIC CLIMATE CONTROL SYSTEM 9

Block diagram - types of Sensors and Actuators, - Control Logic Electrical wiring diagram of manual and automatic system - multiplexing between BCM and PCM- control of compressor clutch, blower motor etc.- diagnostics tools and features.

UNIT IV DESIGN OF AIR-CONDITIONING COMPONENTS 9

Modeling of Fixed and variable Displacement type compressor, evaporator modeling – heat transfer correlations for the fluids inside the evaporator, analysis of evaporator frosting-condenser modeling - improvement of refrigerant flow control method.

UNIT V AIR CONDITIONING DIAGNOSIS AND SERVICES 9

AC system diagnosis based on temperature and pressure measurements, sight glass, sound etc. - refrigerant leak detection- Trouble shooting and Servicing of compressor, evaporator, condenser, heater core – HVAC equipment , recovery and charging. Air routing system service.

TOTAL: 45 PERIODS

OUTCOMES:

- Solve the simple problems related to psychrometry and refrigerant
- Understand the operation of the individual components of the A/System, sensors, actuators and electronic control
- Understand the range of techniques that can be used in diagnosing
- Identify faults which affect system performance
- Provide adequate knowledge in safe working practice. understanding the correct procedures for A/C service and repair

REFERENCES :

1. Tom Birch, “Automotive Heating and Air Conditioning” Pearson Education Inc., 2003.
2. Boyce H. Dwiggins, Jack Erjavec., “Automotive Heating and Air-Conditioning”, Delmer publisher.,2001.
3. William H Crouse and Donald L Anglin, “Automotive air conditioning”, McGraw – Hill Inc.,1990
4. Steven Daly “Automotive Air Conditioning and Climate Control System”, Butterworth-Heinemann., 2006
5. Paul Weiser, “Automotive air conditioning”, Reston Publishing Co Inc., 1990.
6. James D. Halderman, “Automotive Heating, Ventilation, and Air Conditioning Systems”,
7. Pearson Education Inc., 2004.

AM4022	AUTOMOTIVE SAFETY	L T P C
		3 0 0 3

OBJECTIVES:

The course should enable the students:

- To introduce vehicle structural crashworthiness and crash testing
- To introduce pedestrian safety
- To get the knowledge in sensors provided in the vehicle to avoid the crash and to detect the obstacles around the vehicle.
- To understand the fundamentals of sensor data fusion as it relates to ADAS.
- To Understand the concept of the connected vehicle and its role in ADAS and automated vehicles.

UNIT I CONCEPTS OF AUTOMOTIVE SAFETY 9

Automotive safety: Introduction and Types. Active safety: driving safety, conditional safety, Perceptibility safety, operating safety. Passive safety: Design of body for safety. Concept of crumble zone, Safety Cage. Optimum crash pulse, deceleration on impact with stationary and movable obstacles. Design for Crashworthiness. NCAP.

UNIT II PASSIVE SAFETY EQUIPMENTS AND CONVENIENCE SYSTEM 9

Seat belt, Seat belt tightener system and importance, collapsible steering column. Air bags and its activation. Designing aspects of automotive bumpers and materials for bumpers. Steering and mirror adjustment, central locking system, Tire pressure control system, rain sensor system, Automated wiper system.

UNIT III ACTIVE SAFETY 9

Antilock braking system, Stability Control. Adaptive cruise control, Lane Keep Assist System, Collision warning, avoidance system, Blind Spot Detection system, Driver alertness detection System. ADAS

UNIT IV VEHICLE INTEGRATION AND NAVIGATION SYSTEM 9

Looking out sensors and Looking in sensors, Intelligent vision system, Vehicle Integration system. Global Positioning System. Vehicle Navigation System. Road Network.V2V.

UNIT V AUTONOMOUS VEHICLE 9

SAE Levels of Driving Automation, Level 0 – No Driving Automation, Level 1 – Driver Assistance, Level 2 – Partial Driving Automation, Level 3 – Conditional Driving Automation, Level 4 – High Driving Automation, Level 5 – Full Driving Automation.

TOTAL: 45 PERIODS

OUTCOMES:

The students should be able to:

- Know about the design of the bumper for safety.
- Know about the concept of crumble zone, and also the effect of acceleration and deceleration of the vehicle in the compartment of the vehicle.
- Know the various types of safety aspects such as active and passive safety, the active safety components and the working passive safety components such as air bags, seatbelts
- Understand the fundamentals of sensor data fusion as it relates to ADAS.
- Understand the concept of the connected vehicle and its role in ADAS and automated vehicles.

REFERENCES:

1. ARAI Safety standards
2. Bosch, “Automotive HandBook”, 6th edition, SAE, 2004.
3. Ljubo Vlacic, Michel Parent, Fumio Harashima – “Intelligent Vehicle Technologies Theory and Applications” -Butterworth-Heinemann, 2001
4. Marek .J, H.-P. Trah, Y. Suzuki, I. Yokomori - “Sensors for Automotive Applications “ - WILEY-VCH Verlag GmbH & Co. 2003
5. Robert Bosch GmbH - “Safety, Comfort and Convenience Systems”- Wiley; 3rd edition , 2007
6. Surface Vehicle Recommended Practice - SAE J 3016-2018 , SAE International ,2018

Course Outcomes	Programme Outcomes					
	1	2	3	4	5	6
CO1	2	1	3	1	3	2
CO2	3	1	3	2	3	3
CO3	3	2	3	2	2	3
CO4	3	1	3	3	3	3
CO5	2	1	3	2	3	3
CO Contribution (Average)	3	1	3	2	3	3

AM4023 INDUSTRY 4. 0 AND IoT L T P C
3 0 0 3

OBJECTIVES:

The course should enable the students:

- To explore how Industry 4.0 will change the current manufacturing technologies and processes by digitizing the value chain.
- To Understand the drivers and enablers of Industry 4.0.
- To Learn about various IoT-related protocols
- To Build simple IoT Systems using Arduino and Raspberry Pi..

UNIT I INTRODUCTION TO INDUSTRY 4.0 9

Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories, Industry 4.0: Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis

UNIT II INTRODUCTION TO IOT 9

Architectural Overview, Design principles and needed capabilities, IoT Applications, Sensing, Actuation, Basics of Networking, M2M and IoT Technology Fundamentals- Devices and gateways, Data management, Business processes in IoT, Everything as a Service(XaaS), Role of Cloud in IoT, Security aspects in IoT.

UNIT III ELEMENTS OF IOT 9

Hardware Components- Computing (Arduino, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces. Software Components- Programming API‟s (using Python/Node.js/Arduino) for Communication Protocols-MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP

UNIT IV IOT APPLICATION DEVELOPMENT 9

Solution framework for IoT applications- Implementation of Device integration, Data acquisition and integration, Device data storage- Unstructured data storage on cloud/local server, Authentication, authorization of devices. Case Studies: IoT case studies and mini projects based on Industrial automation, Transportation, Agriculture, Healthcare, Home Automation

UNIT V IOT APPLICATION IN AUTOMOBILES 9

Fleet Management: Real-time location monitoring of the fleet, Weight/Volume tracking of cargo that the fleet is carrying, Trucks' performance statistics like fuel and mileage, Tracking traffic conditions on the road, Route management, Time and Driver management, connected cars: Vehicle to vehicle, Vehicle to infrastructure ,Vehicle to pedestrians, Vehicle to network, Automotive Maintenance System: Autonomous vehicle: In-vehicle Infotainment and Telematics:

TOTAL: 45 PERIODS

OUTCOMES:

The students should be able to:

- Explore how Industry 4.0 will change the current manufacturing technologies and processes by digitizing the value chain.
- Understand the drivers and enablers of Industry 4.0.
- Learn about various IoT-related protocols
- Build simple IoT Systems using Arduino and Raspberry Pi.

REFERENCES:

1. Vijay Madisetti, ArshdeepBahga, Ïnternet of Things, “A Hands on Approach”, University Press. 2015.
2. Dr. SRN Reddy, RachitThukral and Manasi Mishra, “Introduction to Internet ofThings: A practical Approach”, ETI Labs, 2017
3. Pethuru Raj and Anupama C. Raman, “The Internet of Things: Enabling Technologies, Platforms, and Use Cases”, CRC Press, 2017.
4. Adrian McEwen, “Designing the Internet of Things”, Wiley, 2015.
5. Raj Kamal, “Internet of Things: Architecture and Design”, McGraw Hill, 2017.
6. CunoPfister, “Getting Started with the Internet of Things”, O Reilly Media, 2011.

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, ஒப்புறவு 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
   ஐந்தினை 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 ஆதின 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	3	3	3	3		3

	Management discipline						
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 sustainability performances.

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 L T 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.

ANNA UNIVERSITY
PROGRESS THROUGH KNOWLEDGE