Y25 M.Tech. - Thermal Engineering

Program Handbook

Program Structure

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	ESC	ESC-CORE	25MT5102	COMPUTATIONAL TECHNIQUES IN ENGINEERING OPTIMIZATION	R	CTEO	2	2	0	0	4	4	
2	PCC	PCC-CORE	25TE5102	DESIGN OF THERMAL SYSTEMS	R	DTS	2	0	2	4	4	8	
3	PCC	PCC-CORE	25TE5103	ADVANCED THERMODYNAMICS	R	ATD	3	0	2	0	4	5	
4	PCC	PCC-CORE	25TE5104	COMPUTATIONAL FLUID DYNAMICS	R	CFD	3	0	2	0	4	5	
5	PCC	PCC-CORE	25TE5205	ADVANCED HEAT AND MASS TRANSFER	R	AHMT	3	0	2	0	4	5	
6	PCC	PCC-CORE	25TE5206	MEASUREMENTS IN THERMAL ENGINEERING	R	MTE	2	0	2	0	3	4	
7	PCC	PCC-CORE	25TE5207	BATTERY AND THERMAL MANAGEMENT SYSTEMS	R	BTMS	3	0	2	4	5	9	
8	PEC	PE-1	25TE51A1	GAS TURBINE ENGINEERING	R	GTE	3	0	2	0	3	4	
9	PEC	PE-1	25TE51A2	ELECTRIC VEHICLE ENGINEERING	R	EVE	3	0	2	0	3	4	
10	PEC	PE-1	25TE51A3	ENERGY CONSERVATION & AUDIT	R	ECA	2	0	2	0	3	4	
11	PEC	PE-2	25TE52B1	ADVANCED ENERGY STORAGE TECHNOLOGIES	R	AEST	2	0	2	0	3	4	
12	PEC	PE-2	25TE52B2	FOOD PROCESSING, PRESERVATION AND TRANSPORT	R	FPPT	2	0	2	0	3	4	
13	PEC	PE-2	25TE52B3	CONVECTION AND TWO-PHASE FLOW	R	CTPF	2	0	2	0	3	4	
14	PEC	PE-3	25TE52C1	RENEWABLE ENERGY SOURCES & TECHNOLOGY	R	REST	3	0	2	0	4	5	
15	PEC	PE-3	25TE52C2	PRINCIPLES OF TURBO MACHINERY	R	PTM	3	0	2	0	4	5	
16	PEC	PE-3	25TE52C3	HEAT EXCHANGER DESIGN	R	HED	3	0	2	0	4	5	
17	PRI	PRI-CORE	25IE6150	DISSERTATION (PART-1)	R	DIS	0	0	32	0	16	32	
18	PRI	PRI-CORE	25IE6250	DISSERTATION (PART-2)	R	DIS	0	0	32	0	16	32	
19	PRI	PRI-CORE	25IE5201	ESSENTIALS OF RESEARCH DESIGN	R	ERD	1	1	0	0	2	2	
20	PRI	PRI-CORE	25IE5149	TERM PAPER	R	TP	0	0	8	0	4	8	
21	OEC	OE-1	25OEBT01	IPR AND PATENT LAWS	R	IPR	4	0	0	0	4	4	
22	OEC	OE-1	25OEIN01	FUNDAMENTALS OF IOT	R	FIOT	4	0	0	0	4	4	
23	VAC	VAC-CERT	25CC3071	PROGRAMMING USING PYTHON	R	PUP	0	0	0	8	0	8	
24	VAC	VAC-CERT	25CC3114	FLOW ANALYSIS USING ANSYS CFD	R	FAACFD	0	0	0	8	0	8	
25	AUC	AUC-CORE	25UC5201	PROFESSIONAL COMMUNICATION SKILLS	R	PCS	0	0	4	0	0	4	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
26	AUC	AUC-CAREER	CRTVQRL1V1	CAMPUS RECRUITMENT: VERBAL APTITUDE TRAINING	R	CRT: VAT	0	0	0	8	0	8	
27	AUC	AUC-CAREER	CRTVQRL2V2	CAMPUS RECRUITMENT: QUANTITATIVE APTITUDE TRAINING	R	CRT: QAT	0	0	0	8	0	8	
28	AUC	AUC-CAREER	CRTVQRL3V3	CAMPUS RECRUITMENT: REASONING APTITUDE TRAINING	R	CRT: RAT	0	0	0	8	0	8	
29	AUC	AUC-CAREER	CRTCSSL1V1	CAMPUS RECRUITMENT: COMMUNICATION SKILLS TRAINING	R	CRT: CST	0	0	0	8	0	8	
30	AUC	AUC-CAREER	CRTCSSL2V2	CAMPUS RECRUITMENT: SOFT SKILLS TRAINING	R	CRT: SST	0	0	0	8	0	8	
31	AUC	AUC-CAREER	CADCORL1V1	CAREER ADVANCEMENT: TRAINING IN CORE DOMAIN	R	CAD: TICD	0	0	0	8	0	8	
32	AUC	AUC-CAREER	CADUPSL1V1	CAREER ADVANCEMENT: UPSC-CIVIL SERVICES EXAM TRAINING	R	CAD: UPSC	0	0	0	8	0	8	
33	AUC	AUC-CAREER	CADENTL1V1	CAREER ADVANCEMENT:ENTREPRENEURIAL CAREER PATHWAY TRAINING	R	CAD: ECPT	0	0	0	8	0	8	
34	AUC	AUC-CAREER	CRTCODL1V1	CAMPUS RECRUITMENT: LOGIC BUILDING SKILLS TRAINING	R	CRT: LBST	0	0	0	8	0	8	
35	AUC	AUC-CAREER	CADCOML1V1	CAREER ADVANCEMENT:COMPETITIVE EXAM TRAINING	R	CAD: COM	0	0	0	8	0	8	

Y25: M.Tech. - Thermal Engineering

Category: Engineering Science Courses (ESC)

25MT5102 - COMPUTATIONAL TECHNIQUES IN ENGINEERING OPTIMIZATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MT5102	COMPUTATIONAL TECHNIQUES IN ENGINEERING OPTIMIZATION	CTEO	R	2	2	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts of optimization, including types of problems, mathematical formulation, and programming implementation.	2	PO1, PO2
CO2	Apply mathematical optimization techniques, both unconstrained and constrained, to solve engineering problems using programming languages like Matlab/Python/R.	3	PO1, PO5
CO3	Analyze and solve multi-objective optimization problems, considering trade-offs and conflicting objectives, using appropriate algorithms and methodologies.	4	PO1, PO5
CO4	Apply optimization techniques to solve application-specific problems in Machine Design and Thermal Engineering domains, demonstrating domain-specific knowledge and skills.	3	PO1, PO5

Syllabus

Introduction to Engineering Optimization: Basics of optimization, mathematical formulations, and algorithms. Applications in mechanical and machine design.

Unconstrained Optimization Techniques: Newton\'s method, gradient descent, conjugate gradient. Implementation in MATLAB/Python.

Constrained Optimization Techniques: Linear and nonlinear constraints, Lagrange multipliers, penalty and barrier methods. Application in mechanical design.

Multi-objective Optimization: Pareto optimality, weighted sum, epsilon-constraint methods. Implementing multi-objective optimization using Python.

Reference Books

1. "Engineering Optimization: Methods and Applications", Ravindran, R., Ragsdell, K. M., & Reklaitis, G. V., 2006, Wiley.

2. "Introduction to Optimization", Chong, E. K. P., & Zak, S. H., 2013, Wiley.

3. "Optimization Concepts and Applications in Engineering", Belegundu, A. D., & Chandrupatla, T. R., 2011, Pearson.

4. "Optimization in Practice with MATLAB?: For Engineering Students and Professionals", Achanta, S., & Darby-Dowman, K., 2015, Cambridge University Press.

5. "Applied Optimization: Formulation and Algorithms for Engineering Systems", Ross, I. J., 1999, Cambridge University Press.

Y25: M.Tech. - Thermal Engineering

Category: Professional Core Courses (PCC)

25TE5102 - DESIGN OF THERMAL SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25TE5102	DESIGN OF THERMAL SYSTEMS	DTS	R	2	0	2	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the modelling concepts to the design of thermal systems	3	PO2
CO2	Analyze the design of thermal systems by considering its economic viability.	4	PO3, PO4
CO3	Analyze the problem formulation for optimization and its search methods and understanding Lagrange multiplier	4	PO3, PO5
CO4	Analyze the Geometric, linear and dynamic Programming and modelling of thermal equipment.	4	PO5
CO5	Analyze the design and Modeling of thermal systems.	4	PO5
CO6	Analyze the models of thermal systems using tools.	4	PO4

Syllabus

Modeling of Thermal Systems: types of models, mathematical modelling, curve fitting, linear algebraic systems, numerical model for a system, system simulation, methods for numerical simulation; Acceptable Design of thermal System: initial design, design strategies, design of systems from different application areas, additional considerations for large practical system.

Economic Considerations: calculation of interest, worth of money as a function of time, series of payments, raising capital, taxes, economic factor in design, application to thermal systems;

Problem Formulation for Optimization: optimization methods, optimization of thermal systems, practical aspects in optimal design, Lagrange multipliers, optimization of constrained and unconstrained problems, applicability to thermal systems; search methods: single-variable problem, multivariable constrained optimization, examples of thermal systems; geometric, linear, and dynami cprogramming and other methods for optimization, knowledge-baseddesign and additional considerations, professional ethics

Optimization, Objective function formulation, Constraint equations, Mathematical formulation, Calculus method, Dynamic programming, Geometric programming, linear programming methods, solution procedures. Equation fitting, Empirical equation, best fit method, method of least squares. Modeling of thermal equipments such as turbines, compressors, pumps, heat exchangers, evaporators and condensers

Reference Books

1   Thermal Design and Optimization, Bejan,G.Tsatsaronis, M.J.Moran, 1th edition, 1995, Wiley.

2   Design&SimulationofThermalSystem s, N.V.Suryanarayan a, 2th edition, 2002, MGH.

3   Design of Thermal Systems, W.F. Stoecker,, 2th edition, 1996, McGraw-Hill.

4   Design and Optimization of Thermal Systems, Y. Jaluria, 1th edition, 2004, CRC Press.

25TE5103 - ADVANCED THERMODYNAMICS   (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25TE5103	ADVANCED THERMODYNAMICS	ATD	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply a review of the Joule-Thompson experiment, the Maxwell equations, the first and second laws of thermodynamics, irreversibility and availability, and energy analysis.	3	PO1, PO5
CO2	Apply thermodynamics entails grasping phase transitions, equilibrium types, multi-component and multi-phase systems, equations of state, chemical thermodynamics, combustion, and the Third Law.	3	PO1, PO5
CO3	Apply the knowledge of the kinetic theory of gases involves understanding molecular flux, the equation of state for an ideal gas, collisions with a moving wall, the principle of equipartition of energy, the classical theory of specific heat capacity, and transport phenomena related to intermolecular forces.	3	PO1, PO5
CO4	Applying fundamental knowledge of statistical thermodynamics involves understanding energy states and levels on macro and micro scales.	3	PO1, PO5
CO5	Analyze advanced thermodynamics and statistical mechanics involves a deep dive into the First and Second Laws.	4	PO5

Syllabus

Review of first and second law of thermodynamics, Maxwell equations, Joule-Thompson experiment, irreversibility and availability, exergy analysis

phase transition, types of equilibrium and stability, multi-component and multi-phase systems, equations of state, chemical thermodynamics, combustion. Third law of thermodynamics,

Kinetic theory of gases introduction, basic assumption, molecular flux, equationof state for an ideal gas, collisions with a moving wall, principle of equi-partition of energy, classical theory of specific heat capacity. Transport phenomena-inter molecular forces, The Vander Waals equation of state, collision cross section, mean free path,

Statistical thermodynamics-introduction, energy states and energy levels, macro and micro-scales, thermodynamic probability, Bose-Einstein, Fermi-Dirac, Maxwell-Boltzmann statistics, distribution function, partition energy, statistical interpretation of entropy, application of statistics to gases-mono-atomic ideal gas.

Advanced thermodynamics and statistical mechanics, First and Second Laws, entropy in phase transitions, Maxwell\'s equations, multi-component phase diagrams, chemical equilibrium, kinetic theory of gases, and transport phenomena for aprofound understanding of physical systems

Reference Books

1   Advanced Thermodynamics for Engineers, Kenneth Wark, 1, McGraw-Hil (1995).

2   Thermodynamics, Kinetic theory, and Statistical thermodynamics, F. W. Sears, and G. L. Salinger, 3, Narosa Publishing House (1975).

3   Fundamentals of Engineering thermodynamics, M. J. Moron, and H. N. Shapiro, 5, John Wiley& Sons (2006).

4   Heat and thermodynamics, M. W. Zemansky, and R. H. Dittman, 8, McGraw Hill International (2017).

25TE5104 - COMPUTATIONAL FLUID DYNAMICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25TE5104	COMPUTATIONAL FLUID DYNAMICS	CFD	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Derive Governing equations of fluid flow and heat transfer and apply finite difference formulation to discretize the governing equations	3	PO1, PO3, PO4
CO2	Analyze heat transfer characteristics in case of steady diffusion problems using finite volume discretization technique	4	PO1, PO3, PO4
CO3	Analyze fluid flow and heat transfer characteristics in case of steady advection diffusion	4	PO1, PO3, PO4
CO4	Formulate explicit and implicit algorithms to solve N-S Equations and to understand the turbulence modelling	4	PO1, PO3, PO4
CO5	Analyze various fluid flow and heat transfer characteristics using a simulation software (Ansys-Fluent)	4	PO1, PO3, PO4, PO7

Syllabus

ntroduction: Conservation equation; mass; momentum and energy equations; convective forms of the equations and general description, Classification and Overview of Numerical Methods: Classification into various types of equation; parabolic elliptic and hyperbolic; boundary and initial conditions; overview of numerical methods, Finite Difference Technique: Finite difference methods; different means for formulating finite difference equation; Taylor series expansion

Finite Volume Technique: Finite volume methods; different types of finite volume grids; approximation of surface and volume integrals; interpolation methods Finite Element Methods :Finite element methods; Rayleigh-Ritz, Galerkin and Least square methods; interpolation functions; one and two dimensional elements; applications, Methods of Solution:; iterative methods; matrix inversion methods;

ADI method; operators plitting; fast Fourier transform, Time integration Methods: Single and multi level methods; predictor-corrector methods; stability analysis; Applications to transient conduction and advection-diffusion problems, Numerical Grid Generation: Numerical grid generation; basic ideas; transformation and mapping,

Navier-Stokes Equations: Explicit and implicit methods; SIMPLE type methods; fractional step methods, Turbulence modeling: Reynolds averaged Navier-Stokes equations, RANS modeling, DNS and LES.

Analyse theoretical concepts of CFD to formulate and conduct numerical experiments using commercial software and coding

Reference Books

1. Essential Computational Fluid Dynamics, Zikanov.O, 2000, Wiley.

2. Fundamentals of CFD, T. K. Sengupta, 2004, University Press.

3. Computational Fluid Mechanics and Heat Transfer, J. C. Anderson, D. A. Tannehil and R. H. Pletcher, 2010, Taylor&Francis.

4. Computational Techniques for Fluid Dynamics, C. A. J. Fletcher,, 2010, Springer.

5. Computational Methods for Fluid Dynamics, J. H. Ferziger and M. Peric, 2006, Springer.

25TE5205 - ADVANCED HEAT AND MASS TRANSFER (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25TE5205	ADVANCED HEAT AND MASS TRANSFER	AHMT	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze 1D steady and unsteady state state heat conduction in various heat transfer applications	4	PO1, PO2
CO2	Analyze Multidimensional and transient heat conduction and heat transfer characteristics in various various heat transfer applications	4	PO1, PO2
CO3	Design heat exchangers by applying the basic heat transfer principles and analyze the radiation heat transfer characteristics	4	PO1, PO2
CO4	Analyze the Diffusion and convective mass transfer in plate and pipes	4	PO1, PO2
CO5	Analyze various the heat transfer characteristics in fins and heat exchangers using Ansys software	4	PO2, PO3, PO4

Syllabus

Introduction - review of heat transfer Fundamentals - transient conduction and extended surface Heat Transfer, Unsteady heat conduction. Lumped capacity model, awareness of one-dimensional unsteady results (charts; Biot and Fourier numbers)

Brief review of Steady Laminar and Turbulent Heat Transfer in External and Internal Flows - Heat Transfer at High Speeds - Unsteady Laminar and Turbulent Forced Convection in Ducts and on Plates - Convection with body forces, Boundary layers and internal flows. Awareness of these configurations, some knowledge of internal flow energy balances, Convection correlations. Finding heat transfer coefficients from Reynolds numbers and Rayleigh numbers

Heat Exchangers. Typical configurations and epsilon-NTU analysis, phase-change heat transfer. General awareness of processes of condensation and boiling in a pure substance, some use of correlations, Quenching of metals, Leidenfrost problem, heat transfer of sprays, jets and films, Radiation basics -Radiation in Enclosures - Gas Radiation

Diffusion and Convective Mass Transfer - Combined Heat andMass Transfer from Plates and in Pipes.

Reference Books

1 Heat Transfer, A. Bejan, 5th edition: 1993, John Wiley & Sons.

2 Advanced Heat and Mass Transfer, A.Faghri, Y. Zhang, J. Howell, 3rd edition: 2010, Global Digital Press.

3 Heat Transfer, P.S.Ghoshdatidar, 3rd Edition: 2004, Oxford University Press.

4 Heat and Mass Transfer: Fundamentals and Applications, Yunus A. ?engel, Afshin J. Ghajar, 5th Edition:2015, McGraw-Hill Education.

25TE5206 - MEASUREMENTS IN THERMAL ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25TE5206	MEASUREMENTS IN THERMAL ENGINEERING	MTE	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply scientific and engineering methods for the measurement of field and derived quantities	3	PO1
CO2	Analyze principles of presentation, estimation and data analysis	4	PO2
CO3	Apply various experimental measurement techniques for the measurement of field quantities with probe and non-instructive techniques	3	PO3
CO4	Evaluate the measurement of derived quantities and analytical methods and design and conduct the experiments, as well as to organize, analyze and interpret data to produce meaningful conclusions and recommendations	4	PO4
CO5	Analyze the various measurement of the thermal engineering components	4	PO5

Syllabus

Introduction to measurements for scientific and engineering applications- need and goal - broad category of methods for measuring field and derived quantities

Principlesofmeasurement-parameterestimation-regressionanalysis-correlationserrorestimation and data presentation - analysis of data;

Measurement of field quantities -thermometry-heat flux measurement-measurement of force, pressure, flowrate, velocity, humidity, noise, vibration- measurement of the above by probe and nonintrusive techniques

Measurement of derived quantities-torque,power,thermo-physical properties - radiation and surface properties; Analytical methods and pollutionmonitoringmassspectrometry-chromatography-spectrosc

Reference Books

1 Fluid mechanics and measurements, ,R.J.Goldstein , 1th edition, 2005, Taylor Francis.

2 Hand book of experimental fluid mechanics, C.Tropea,Y.Alexander,J.F.Foss , 2th edition, 1994, Springer.

3 Experiments and Uncertainty Analysis for Engineers, H.W. Coleman and W.G. Steele Jr, 1th edition, 1997, Wiley & Sons, .

4 Fundamentals of temperature, pressure and flow measurement, R. P. Benedict, 2th edition, 2008, John Wiley and Sons.

25TE5207 - BATTERY AND THERMAL MANAGEMENT SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25TE5207	BATTERY AND THERMAL MANAGEMENT SYSTEMS	BTMS	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Select suitable battery for EV application	3	PO1
CO2	Compare the materials used for the components of the battery	4	PO2
CO3	Conduct tests on battery cells to determine various performance and operating parameters	4	PO3
CO4	Estimate heat generation inside battery and propose cooling strategy for the battery pack.	4	PO4

Syllabus

History of Battery cells, Primary Battery, Secondary Battery, Performance parameters and operating variables of Battery, Electric vehicle (EV) requirements, Battery Technologies for EV applications, Lead Acid battery, Nickel Cadmium, Nickel Metal Hydrite, Lithium-Ion Batteries: Working, chemical reactions, comparison, future battery trends and challenges, Metal-Air Batteries, fuel cells, ultra-capacitors

Introduction, Components, Functions, Cathode Materials, Anode Materials, Electrolytes: salts and solvents, separators, advantages and drawbacks, Battey cell Manufacturing: Cylindrical, prismatic and Pouch cells, recycling/disposal of batteries

Battery operating and performance parameters, Charge-discharge characteristics of batteries, Measurement of current, voltage, temperature, Estimation of SOC: Coulomb Counting method, OCV method, Estimation of SoH, Capacity, efficiency

Heat Generation inside battery, Thermal issues of Lithium-Ion Battery, impact of temperature on capacity, cycle life, Thermal Runaway, Cooling strategies: Direct/indirect cooling, Air cooling, liquid cooling, PCM based cooling, advanced colling methods

Reference Books

1. Battery Management Systems, Gregory L. Plett,, 1th edition, 2006, Artech House, London.

2. Li-I Batteries Basics and Applications, Reiner_Korthauer, 2th edition, 1990, Springer International Publication.

3. Fundamentals and Application of Lithium-ion Batteries in Electric Drive Vehicles, Jiuchun Jiang, Caiping Zhang -, 2th edition, 1996, Wiley.

4. Thermal Energy Storage Systems and Applications,, Ibrahim Dincer and Mark A. Rosen, 2th edition, 2009, Wiley & Sons.

Y25: M.Tech. - Thermal Engineering

Category: Professional Elective Courses (PEC)

25TE51A1 - GAS TURBINE ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25TE51A1	GAS TURBINE ENGINEERING	GTE	R	3	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concepts of air standard cycle to analyse the performance of ideal and actual gas turbine cycles	3	PO1
CO2	Apply gas turbine theory to jet propulsion and understand fabrication techniques of components	3	PO1
CO3	Analyze the performance of compressors and combustion chambers.	4	PO2
CO4	Analyze the performance of gas turbine and cogeneration systems.	4	PO2
CO5	Analyze troubleshooting of gas turbine systems in various mechanical and aerospace applications.	4	PO2

Syllabus

Thermodynamics of gas turbines: Cycle analysis; Gas Turbine Components: compressor, combustor, heat exchangers, turbine - description: analytical considerations, performance.

Matching of compressor and turbine: cooling of turbine blades. Compressor and turbine impeller construction, blade fixing details, sealing; Material selection for components

Protective coating for hot turbine parts, Components fabrication techniques, Gas turbine turbocharger, gas turbine power generation, turbo expander, gas turbine application, Closed cycle gas turbines

Co-generation-Introduction, Thermodynamics of co-generation, Criteria for component performance, Some practical schemes

Reference Books

1   Aircraft Propulsion and Gas Turbine Engines, AhmedF.El-Sayed , 1, CRCpress,2008.

2   Turbine, Compressors and Fans , S.M. Yahya, 1, MC Grahill.

3   Gas Turbine Theory, H.I.H. Saravanamuttoo, G.F.C. Rogers, and H. Cohen, 7, Pearson.

4   Gas Turbine Performance, Philip P. Walsh and Paul Fletcher, 1, Wiley.

25TE51A2 - ELECTRIC VEHICLE ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25TE51A2	ELECTRIC VEHICLE ENGINEERING	EVE	R	3	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Hybrid /EV Vehicles and study of vehicle dynamics	3	PO1, PO2
CO2	Apply Architecture of Hybrid/EV Vehicles, components and Battery EV	3	PO1, PO2, PO3
CO3	Apply and analyse Fuel Cell, DC/AC Drives and SRM	3	PO1, PO3, PO4
CO4	Apply EV Controls, Controller, and control strategies	4	PO1, PO2, PO4
CO5	Analyze and apply theoretical concepts to develop mathematical models and simulate the Combustion and EV Vehicles	5	PO2, PO3, PO5

Syllabus

:Introduction: Electric Vehicle History, Components of Electric Vehicle, Comparison with Internal combustion, Engine: Technology, Comparison with Internal combustion Engine: Benefits and Challenges, EV classification and their electrification levels, EV Terminology Motor Torque Calculations for Electric Vehicle:

Calculating the Rolling Resistance, calculating the grade resistance, Calculating the Acceleration Force, Finding the Total Tractive Effort, Torque Required On The Drive Wheel. Electric Vehicle Architecture Design:

Types of Electric Vehicle and components, Electrical protection and system requirement, Photovoltaic solar based EV design, Battery Electric vehicle (BEV), Hybrid electric vehicle (HEV), Plug-in hybrid vehicle(PHEV), Fuel cell electric vehicle (FCEV), Electrification Level of EV, Comparison of fuel vs Electric and solar power, Solar Power operated Electric vehicles. Electric Drive and controller:

Types of Motors, Selection and sizing of Motor, RPM and Torque calculation of motor, Motor Controllers, Component sizing, Physical locations, Mechanical connection of motor, Electrical connection of motor.

Reference Books

1   Vehicular Electric Power Systems, Ali Emadi, Mehrdad Ehsani, John M. Miller, 1, Marcel Dekker Publications.

2   Vehicle Dynamics- Theory & Practice, Reza N. Jazar, 1, Springer Publications..

3   Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Husain, 5, CRC Press.

25TE51A3 - ENERGY CONSERVATION & AUDIT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25TE51A3	ENERGY CONSERVATION & AUDIT	ECA	R	3	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the energy auditing methods to meet the energy conservation and various tariffs	2	PO2
CO2	Apply the energy conservation techniques to power system elements	3	PO5
CO3	Understand the energy conservation opportunities in industrial motors and lighting systems	2	PO3
CO4	Understand the energy conservation opportunities incooling systems and cogeneration	2	PO2
CO5	Apply energy conservation techniques in electrical installations	3	PO5

Syllabus

Role of energy in economic development and social transformation, Energy Sources and Overall Energy demand and availability, Energy Conservation Act-2001 & 2003. Electricity Tariff. Energy Audit, Need, Types, Methodology and Approach.

Energy Management Approach, Understanding Energy Costs, Bench marking, Energy performance, matching energy usage to requirements, maximizing system efficiency. Instruments Used in Energy Auditing, Energy Conservation opportunities in Transformers and cables. Energy Conservation opportunities in Transmission lines, P.F. improvements, Demand Side management (DSM), Variable speed drivers.

Electric Motors Types, Losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, Energy efficient motors and Soft starters.

Energy conservation opportunities. Illumination / Lighting Systems: Light source, choice of lighting, luminance requirements, electronic ballast, occupancy sensors, energy efficient lighting control. LED Ligh ting, Trends and Approaches.

Energy conservation opportunities in HVAC, Refrigeration and Air Conditioning systems, Energy Saving in Pumps & Pumping Systems. Energy Conservation Opportunities in Public and Private Buildings, Concepts of Cogeneration. Peak Demand controls- Methodologies

Reference Books

1   Energy-Efficient Electric Motors and their applications , Howard E.Jordan, 2, Plenum pub corp.

2   Energy Management Hand book , Turner, Wayne C, 2, The Fairmont press.

25TE52B1 - ADVANCED ENERGY STORAGE TECHNOLOGIES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25TE52B1	ADVANCED ENERGY STORAGE TECHNOLOGIES	AEST	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand various thermal storage systems and storage materials	2	PO1
CO2	Analyze the sensible and latent heat concepts and develop a heat storage units	4	PO2
CO3	Apply the basics of storage systems to understand the various thermal storage systems	3	PO1
CO4	Apply the principles of heat storage systems on regenerators and its applications	3	PO1
CO5	Analyze various energy storage Systems using using a commercial software Ansys-Fluent	4	PO1

Syllabus

Necessity of thermal storage, types, energy storage devices , comparison of energy storage technologies, seasonal thermal energy storage

Basic concepts and modelling of heat storage units , modelling of simple water and rock bed storage system , use of TRNSYS ,pressurized water storage system for power plant applications

Modelling of phase change problems , temperature based model , enthalpy model , porous medium approach ,conduction dominated phase change, convection dominated phase change

Specific areas of application of energy storage , food preservation, waste heat recovery ,solar energy storage , green house heating , power plant applications, drying and heating for process industries

Reference Books

1   Energy Production and Storage , Crabtree R.H, 1, Wiley.

2   Energy Storage Fundamentals, Materials and Applications, Huggins & Robert, 1, Springer .

3   Thermal Energy Storage Systems and Applications, Ibrahim Dincer and Mark A. Rosen, 1, Wiley & Sons.

4   Advanced Energy Storage Technologies and Their Applications, Junsheng Zhang and Shaohua Jia, 2, MDPI.

25TE52B2 - FOOD PROCESSING, PRESERVATION AND TRANSPORT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25TE52B2	FOOD PROCESSING, PRESERVATION AND TRANSPORT	FPPT	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply food preservation methods and understand the factors effecting food deterioration	3	PO1
CO2	Analyse the different types of drying and food concentration methods	4	PO1
CO3	Analyse the role of natural, chemical preservatives and recent preservation techniques	4	PO2
CO4	Analyse the effect of molecules in transport mechanisms	4	PO2
CO5	Analyse the transport of goods under varying conditions	4	PO2

Syllabus

Food and its preservation Food preservation - Need, importance, principals and methods. Perishable and non perishable foods, concept of shelf life- definition and factors affecting water activity in food and its significance in food preservation, factors affecting food deterioration

Drying- Theory and Mechansim, drying characteristics of materials, preliminary processing, Sun drying vs dehydration, Driers - Air convection driers and types, Drum /Roller Drier, Vacuum drier, Belt drier, tunnel drier, spray drier, rotary drier, fluidized bed drier, Freeze drying and microwave drying

Use of high temperature- principle and equipments: Methods - pasteurization, blanching, sterilization , canning-procedure, canning of acid foods and nonacid foods, aseptic canning nutritive value of canned foods, types of spoilage in canned foods, storage of canned foods, influence of canning on the quality of food

Introduction to transport phenomena. Molecular transport mechanism, transport properties and their proportionality constants in momentum, energy and mass transfer. Mass transfer

Reference Books

1   Food Microbiology, William C Frazier & Dennis C Westhoff, 2013, Tata McGraw Hill Publications.

2   Food Science, Norman N Potter Joseph H Hotchkiss, 2005, CBS Publishers.

3   The Technology of Food Preservation, Norman W Desrosier James N Desrosier, 2006, CBS Publishers.

4   Food Processing and Preservation, B. Sivasankar P, 2002, PHI Learning Pvt Ltd.

5   Introduction to Food Science and Technology, Stewart GP and Amerine MA, 2012, Elsevier.

25TE52B3 - CONVECTION AND TWO-PHASE FLOW (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25TE52B3	CONVECTION AND TWO-PHASE FLOW	CTPF	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the knowledge of fluid mechanics and heat transfer to understand the two-phase flow phenomena	3	PO1, PO3
CO2	Analyze various boiling mechanisms	4	PO1, PO3, PO5
CO3	Analyze various condensation mechanisms	4	PO1, PO3, PO5
CO4	Analyze the performance of various devices based on two-phase flow and heat transfer	4	PO3
CO5	Simulate and analyse two phase flows with and without phase change	4	PO3, PO7

Syllabus

Introduction to two-phase flow and heat transfer technology, Liquid-vapor phase change phenomena, Interfacial tension, Wetting phenomenon, Contact angles, Transport effects, Dynamic behavior of interfaces, Phase stability and nucleation, Two-phase flow fundamentals, Flow patterns and map representation

Development of homogeneous, separated flow and drift flux models, Flooding mechanisms, Boiling Fundamentals, Homogeneous and heterogeneous nucleation, Pool boiling and convective flow boiling, Heat transfer and CFH mechanisms, Enhancement techniques

Condensation fundamentals, External and internal condensation, Film condensation theory, Drop-wise condensation theory, Enhancement techniques micro-scale boiling and condensation, atomistic nucleation models.

Application of two-phase flow and heat transfer, Electronics thermal management, Latent heat storage devices, Gravity assisted thermo-siphons/Vapor chambers, Theory and operation of Conventional heatpipes, Micro heatpipes, Pulsating heat pipes, Capillary pumped oops/Loop heatpipes, Micro two-phase heat exchangers, Static and dynamic instabilities,

Simulate and analyse two phase flows with and without phase change. Film condensation theory, Drop-wise condensation theory, Enhancement techniques micro-scale boiling and condensation, atomistic nucleation models.

Reference Books

1   Heat Transfer Characteristics in Boiling and Condensation, KarlStephan, 1976, Springer.

2   Liquid Vapor Phase Change Phenomena, Van P. Carey, 2020, Taylor & Francis.

3   Two-phase Flow and Heat Transfer, P. B. Whalley, 2005, Oxford Engineering Science.

4   One Dimensional Two-Phase Flow, , G. B. Wallis, 2020, TMH.

25TE52C1 - RENEWABLE ENERGY SOURCES & TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25TE52C1	RENEWABLE ENERGY SOURCES & TECHNOLOGY	REST	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand concept of various forms of Non-renewable and renewable energy	2	PO3
CO2	Outline division aspects and utilization of renewable energy sources for both domestics and industrial applications	2	PO3
CO3	Study the environmental and cost economics of using renewable energy sources compared to fossil fuels	2	PO3
CO4	Understand the commercial energy and renewable energy sources. Know the working principle of various energy systems	2	PO3
CO5	Apply RET Screen software in feasibility analysis for the installation of Solar PV and water heater	4	PO3

Syllabus

Renewable Energy Sources in India - Potential sites, availability. Solar Energy: Measurement and collection, flat plate collectors, concentrating collectors, solar ponds

photovoltaic conversion, Thermal energy storage. Ocean Energy: Principles of OTEC; wave energy, tidal energy, energy conversion systems. Wind Energy: Principle, potential and status; Wind Characteristics; National Wind Atlas; Theory of wind turbine blades; Types of wind turbines and their characteristics.

Biofuels: Sources and potential, properties and characterization; Biogas generation through aerobic and anaerobic digestion; Thermochemical methods of biofuel utilization: Combustion and gasification; Status of biofuel technology

Geothermal Energy-Nature, types and utilization. Applications: Applications of renewable energy sources-Typical examples.

Reference Books

1   Renewable Energy Resources, Twidell, 4, 2021, CRC Press.

2   Renewable Energy, Power for a Sustainable Future, Godfrey Boyle, 3, 2012, Oxford University Press.

3   Wind Energy Conversion systems, L. L. Freris, 1, 1990, Prentice Hall.

4   Renewable Energy Resources: Basic Principles and Applications, Tiwari and Ghosal, 1, 2005, Alpha Science International.

25TE52C2 - PRINCIPLES OF TURBO MACHINERY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25TE52C2	PRINCIPLES OF TURBO MACHINERY	PTM	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyse the design principles of turbomachinery to improve and optimize its performance	4	PO2
CO2	Design the performance of Turbo machines for engineering applications	5	PO3
CO3	Analyse the energy transfer process in Turbomachines and governing equations of various forms.	4	PO2
CO4	Design various Turbomachines for power plant and aircraft applications	5	PO3
CO5	Design and Maintain Turbomachinery Using Ansys Simulation Solutions	5	PO3

Syllabus

Classification - Specific work - Representation of specific work in T-s and h-s diagrams -Internal and external losses

Euler\'s equation of turbo-machinery - Ideal and actual velocity triangles-Slip and its estimation-Impulse and reaction type machines

Degree of reaction - Effect of outlet blade angle on blade shape - Model laws, specific speed and shape number-Special features of hydro, steam and gas turbines

Performance characteristics of turbo-machines-Cavitation, Surge and Stall-Thin aerofoil theory - Cascade mechanics.

Use of CFD for Turbo-machinery analysis and design.

Reference Books

1   Fundamentals of Turbomachinery, WilliamW.Peng, 4, 2020, JohnWiley&Sons.

2   Principles of turbomachinery, D.G.Shepherd, 3, 2011, Macmilan.

3   Aircraft Propulsion and Gas Turbine Engines, AhmedF.El-Sayed, 3, 2009, CRCpress.

4   Hydraulic and Compressible Flow Turbo machines, A.T.Sayers, 2, 2008, Mc-GrawHill.

25TE52C3 - HEAT EXCHANGER DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25TE52C3	HEAT EXCHANGER DESIGN	HED	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Classify heat exchangers and understand thermo-hydraulicfundamentals of the exchangers	2	PO1
CO2	Apply LMTD and effectiveness NTU methods for the design of different typesof shell and tube heat exchangers	3	PO3
CO3	Apply different methods in the design of shell and tube heat exchangers	3	PO3
CO4	Design of Compact heat exchangers and study of fouling control techniques	3	PO3
CO5	Analyze the performance of various heat exchangers and optimize the design parameters using ANSYS software	4	PO3

Syllabus

Heat Exchangers: Introduction, Classification, and Selection. Heat Exchanger: Thermo Hydraulic Fundamentals

Heat Exchanger Design. Compact Heat Exchangers. Shell and Tube Heat Exchanger Design.Regenerators. Plate Heat Exchangers and Spiral Plate Heat Exchangers

Heat-Transfer Augmentation. Fouling;Flow-Induced Vibration of Shell and Tube Heat Exchangers. Mechanical Design of Shell and Tube HeatExchangers.

Corrosion; Material Selection and Fabrication. Quality Control and Quality Assurance andNondestructive Testing. Heat Exchanger Fabrication

Reference Books

1   Heat Exchangers: Selection, Design and Construction, E. A. Saunders, Longman, 1988, Scientific and Technical.

2   Fundamentals of Heat Exchanger Design, Ramesh K. Shah, Dusan P. Sekulic, , 2002, Wiley.

3   Heat Exchanger Design, Arthur P. Fraas, 2nd Edition: 1989, Wiley.

4   Heat Exchangers: Selection, Rating, and Thermal Design, Sadik Kaka?, Hongtan Liu, 3rd Edition :2002, CRC Press.

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25IE5149 - TERM PAPER (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IE5149	TERM PAPER	TP	R	0	0	8	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Literature Review and Problem Identification	2	PO1, PO2, PO4
CO2	Understand Methodology and Implementation	2	PO1, PO2, PO4

Syllabus

Literature Review and Problem Identification

Methodology and Implementation

Reference Books

1   Research methodology, C R Kothari, Ist Edition, New Age International Publishers.

2   Research Methodology, Panneerselvam R, Ist Edition, PHI.

3   Research Methodology: A Step-by-Step Guide for Beginners, Ranjit Kumar, Ist Edition, SAGE Publications Ltd.

4   Researching Lived Experience Human Science for an Action Sensitive Pedagogy, Max Van Manen, Ist Edition, State Univ of New York Pr.

25IE5201 - ESSENTIALS OF RESEARCH DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IE5201	ESSENTIALS OF RESEARCH DESIGN	ERD	R	1	1	0	0	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze existing research to identify a focused and answerable research question or develop a well-defined hypothesis	4	PO1, PO2
CO2	Evaluate different research designs based on their strengths and weaknesses in relation to the chosen research question and data needs.	4	PO2, PO6, PO7
CO3	Apply appropriate data collection methods considering the chosen research design and data characteristics.	3	PO1, PO6
CO4	Analyze and interpret data using relevant data analysis methods to address the research question	4	PO7

Syllabus

Definition and objectives of Research Types of research, Various Steps in Research process, Applied Mathematical tools for analysis, developing a research question- Choice of a problem, Literature review, Surveying, Synthesizing, critical analysis, reading materials, reviewing, rethinking, critical evaluation, interpretation, Research Purposes, Ethics in research APA Ethics code.

Literature Review (LR) Meaning and its Types-Narrative and Systematic, LR using Web of Science, Google and Google Scholar, Citations-Types, referencing in academic writing, Citation vs Referencing Vs Bibliography, Citation tools Zotero, Qualitative Research and its methods, Quantitative Research, and its Methods. Data Collection-Primary data collection using Questionnaire, Google forms, survey monkey, Testing the validity and Reliability of Questionnaire using Factor Analysis and Cronbach\'s Alpha

Diagrammatic and graphical presentation of data: Diagrams and Graphs of frequency data of one variable- histogram, bar charts simple, sub divided and multiple; line charts, Diagrams and Graphs of frequency data of two variables scatter plot, preparing data for analysis. Concepts of Correlation and Regression, Fundamentals of Time Series Analysis and Error Analysis. Analysing data using one dimensional statistics, two-dimensional statistics and multidimensional statistics.

Technical Writing and Publishing, Conference presentations, Poster Presentations, Plagiarism check and tools, Self Plagiarism. Structure and Components of Research Report, Types of Report, Layout of Research Report, Mechanism of writing a research report, Design Thinking for Contextualized Problem Solving and Empathetic Research.

Reference Books

1 Business Research Methods , Donald R.Cooper, Pamela S. Schhindler, 12th , McGraw-Hill.

2 Research Methods, Nicholas Walliman,Routledge, 3rd, The Taylor & Francis Group.

3 Essentials of Research Design and Methodology, David DeMatteo,Geoffrey R. Marczyk, 4th, wiley .

4 Research Design: Qualitative, Quantitative, and Mixed Methods Approaches , J. David Creswell, 6th, wiley.

25IE6150 – DISSERTATION (PART-1) (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IE6150	DISSERTATION (PART-1)	DIS	R	0	0	32	0	16

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Identify and articulate research problems within their field of study, demonstrating an understanding of current research gaps.	4	PO1, PO5
CO2	Design and execute research methodologies, employing relevant techniques for data collection, analysis, and interpretation.	5	PO2, PO6
CO3	Demonstrate advanced critical thinking skills, analyzing research findings within the context of existing literature to draw meaningful conclusions.	5	PO2, PO5

Syllabus

Identify and articulate research problems within their field of study, demonstrating an understanding of current research gaps.

Design and execute research methodologies, employing relevant techniques for data collection, analysis, and interpretation.

Demonstrate advanced critical thinking skills, analyzing research findings within the context of existing literature to draw meaningful conclusions.

Reference Books

1. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, John W. Creswell and J. David Creswell, 2018, SAGE Publications.

2. Engineering Research Methodology: A Practical Insight for Researchers, Dipankar Deb, Brojo Kishore Mishra, and Jayanta Bhattacharya, 2019, Springer.

3. Essentials of Research Methodology for Engineers, Pradip Kumar Sahu, 2020, Springer.

4. Advanced Research Methods for Engineers, Ali Salehnia and Ebrahim Pouresmaeil, 2018, Elsevier.

25IE6250 - DISSERTATION (PART-2) (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IE6250	DISSERTATION (PART-2)	DIS	R	0	0	32	0	16

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate a comprehensive understanding of a chosen research topic and its significance in the broader field.	4	PO1, PO6
CO2	Apply appropriate research methodologies to address research questions	3	PO2, PO5
CO3	Analyze and interpret data effectively, drawing meaningful conclusions	4	PO1, PO6

Syllabus

Demonstrate a comprehensive understanding of a chosen research topic and its significance in the broader field.

Apply appropriate research methodologies to address research questions

Analyze and interpret data effectively, drawing meaningful conclusions

Reference Books

1 Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, John W. Creswell and J. David Creswell, 2018, SAGE Publications.

2 Engineering Research Methodology: A Practical Insight for Researchers, Dipankar Deb, Brojo Kishore Mishra, and Jayanta Bhattacharya, 2019, Springer.

3 Essentials of Research Methodology for Engineers, Pradip Kumar Sahu, 2020, Springer.

4 Advanced Research Methods for Engineers, Ali Salehnia and Ebrahim Pouresmaeil, 2018, Elsevier.

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Category: Open Elective Courses (OEC)

25OEBT01 - IPR AND PATENT LAWS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25OEBT01	IPR AND PATENT LAWS	IPR	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the the principles of copy rights in applying patents, trademarks, copyrights, and trade secrets	2	PO6
CO2	Apply the guidelines framed by GATT & WTO in patenting	3	PO6
CO3	Apply the regulatory affairs in maintaining patenting rights	3	PO6
CO4	Apply the concepts of copy rights in drafting patents of various types.	3	PO6

Syllabus

Intellectual Property Rights; Patents and intellectual property rights (IPR): Definition,History of intellectual property; Types of intellectual property rights, copy rights, trade marks, geographical indication, Industrial design rights, patents. Sources of patent information, patent application procedures

Principles, Scope and Functions of GATT&WTO; GATT- Historical perspective, objectives and fundamental principles, impact on developing countries. WTO-Objectives, scope, functions, structure, status, membership and withdrawal, dispute settlement, impact on globalization, India tasks and challenges

Regulatory Affairs; Indian contest-requirements and guidelines of GMP, understanding of Drugs and cosmetic act 1940 and rules 1945 with reference schedule M,U & Y. Related quality systems-objectives and guidelines of USFDA,WHO & ICH; Introduction to ISO series

Documentation and Protocols; Documentation: Types related to pharmaceuticals industry, protocols, harmonizing formulation development for global fillings, NDA, ANDA, CTD, Dealing with post approval changes-SUPAC, handling and maintenance including electronic documentation. self study topic: Case Studies on Patents and Case Studies on - Patents (Basmati rice, turmeric, Neem, and related medicinal plants and byproducts)

Reference Books

1. Patent Law and Policy: Cases and Materials, Robert Patrick Merges, John Fitzgerald Duffy, and Mark D. Lemley, 2021, Carolina Academic Press.

2. Intellectual Property Rights: Legal and Economic Challenges for Development, Carlos M. Correa, 2020, Oxford University Press .

3. Principles of Intellectual Property Law, Thomas G. Field Jr., 2021, New Hampshire.

4. Good manufacturing practices for Pharmaceuticals, Informa Healthcare, S.H. Willig, 2010, Academic Press.

5. IPR,Biosafety and Bioethics, Deepa Goel, Shomini Parashar, 2021, Pearson .

25OEIN01 - FUNDAMENTALS OF IOT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25OEIN01	FUNDAMENTALS OF IOT	FIOT	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basic concepts of IoT and its implementation using the Development Hardware.	3	PO1
CO2	Apply the different sensors interfacing with Development Hardware.	3	PO1
CO3	Apply the different actuators interfacing with Development Hardware.	3	PO1
CO4	Analyze the IoT concepts to solve real time insights using Arduino / ESP32.	4	PO1

Syllabus

This module covers digital components (multiplexer, de-multiplexer, encoder, decoder), the ATMEGA328P microcontroller, and Arduino (types, features, pin descriptions, IDE, applications, GPIO programming).

It covers sensor basics, types, and classifications, focusing on temperature sensors (thermistors, LM35), LDR, IR, PIR, ultrasonic, and gas sensors, along with their interfacing and application implementations.

This module introduces actuators and their interfacing, covering types of DC motors, servo motors, and stepper motors along with their applications. It also includes motor driver circuits, relays, and optocouplers.

It covers IoT case studies on home automation, smart irrigation, and healthcare, with self-learning topics like smart lighting, intrusion detection, and air pollution monitoring.

Reference Books

1 Internet of Things (A-Hand-on-Approach), Arshdeep Bahga and Vijay Madisetti, 1st edition, 2015, Universities Press.

2 Internet of Things, Rajkamal, 2012, Tata McGraw Hill.

3 Internet of Things Architectures, Protocols and Standards, Simone Cirani, Gianluigi Ferrari, Marco Picone, Luca Veltri, 1st edition, 2019, Wiley.

4 The Internet of Things: Key applications and Protocols , Olivier Hersent, David Boswarthick, Omar Elloumi , 2012, Wiley.

5 The Internet of Things: Connecting Objects, Hakima Chaouchi, 2013, Wiley.

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Category: Value Added Courses (VAC)

25CC3071 - PROGRAMMING USING PYTHON (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CC3071	PROGRAMMING USING PYTHON	PUP	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Python Modules and Packages	2	PO3
CO2	Apply Exception handling and string methods in Python	3	PO3
CO3	Apply object-oriented programming in python	3	PO3
CO4	Apply functions and Input/Output operations in python	3	PO3

Syllabus

Modules and Packages: Import and use modules and packages, Perform evaluations using the math module, Generate random values using the random module, Discover host platform properties using the platform module, Create and use user-defined modules and packages.

Exceptions: Handle errors using Python-defined exceptions, Extend the Python exceptions hierarchy with self-defined exceptions. Strings: Understand machine representation of characters, Operate on strings, Employ built-in string methods.

Object-Oriented Programming: Understand the Object-Oriented approach, Employ class and object properties, Equip a class with methods, Discover the class structure, Build a class hierarchy using inheritance, Construct and initialize objects.

Miscellaneous: Build complex lists using list comprehension, Embed lambda functions into the code, Define and use closures, Understand basic Input/Output terminology, Perform Input/Output operations.

Reference Books

1 Programming Python, Mark Lutz, 2001, O'Reilly Media.

2 Learning Python: Powerful Object-Oriented Programming, Mark Lutz, 2013, O'Reilly Media.

3 Python for Everyone, Cay Horstmann and Rance Necaise, 2016, John Wiley & Sons, Inc..

4 Programming and Problem Solving with Python , Ashok Namdev Kamthane and Amit Ashok Kamthane, 2018, McGraw Hill Education (India) Private Limited.

5 Starting Out with Python , Tony Gaddis, 2019, Pearson Education Limited.

25CC3114 - FLOW ANALYSIS USING ANSYS CFD (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CC3114	FLOW ANALYSIS USING ANSYS CFD	FAACFD	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply governing equations to create geometry / model for the flow field	3	PO1, PO3, PO4
CO2	Perform fluid flow and heat transfer analysis for external and internal flow fields	4	PO1, PO3, PO4

Syllabus

Introduction to CFD, Conservation of mass, momemtum and energy equations, Navier Stokes equation of motion. Introduction to Ansys Fluent Workbench-Creation or Importing of geometry using Ansys Design Modeler and Space Claim

Analysis of fluid flow through pipe, T-Junction, Duct flows, enclosures, Double pipe heat exchanger, Shell and Tube heat exchanger, and spiral heat exchanger. Heat transfer analysis in various heat exchangers and enclosures

Reference Books

1   Essential Computational Fluid Dynamics, Zikanov.O, 2000, Wiley.

2   Fundamentals of CFD, T. K. Sengupta, 2004, University Press.

3   An Introduction to ANSYS Fluent 2022, John.E, Mattson, 2022, SDC Publications.

4   Computational Fluid Mechanics and Heat Transfer, J. C. Anderson, D. A. Tannehil and R. H. Pletcher, 2010, Taylor&Francis.

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Category: Audit Courses (AUC)

25UC5201 - PROFESSIONAL COMMUNICATION SKILLS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25UC5201	PROFESSIONAL COMMUNICATION SKILLS	PCS	R	0	0	4	0	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop the skill of contextual Vocabulary and Critical Reading	3	PO7
CO2	Demonstrate different types of personal and professional skills and apply them for growth in professional zone.	3	PO7
CO3	Apply the concepts of Mathematical Principles to solve problems on Arithmetic , Algebra & Geometry to improve problem solving ability.	3	PO3
CO4	Apply the concepts and using Logical thinking to solve problems on verbal & Non-Verbal Reasoning to develop Logical thinking skills.	3	PO3

Syllabus

Vocabulary: Synonyms, Antonyms and One-word substitutes, (B)Reading comprehension, Critical reading, (C) Writing skills: Email writing, report writing and paragraph writing (D) Listening/Speaking Skills: listen & speak, Functional grammar

- A)Personal Skills: Intra & Interpersonal skills (B) Assertiveness (C) Group Discussion (D) Resume writing (E) Video resumes (F) Interview skills

Simple Equations, Ratio & Partnership, Averages, Percentages, Profit & Loss, Simple & Compound Interest, Numbers, Quadratic Equations & Inequalities, Time & Work, Time, Speed & Distance, Permutations & Combinations, Probability, Mensuration, Data Interpretation.

Syllogism, Logical Venn Diagrams, Cubes & Dice, Number& letter series, Number, letter & word Analogy, Odd Man Out, Coding & Decoding, Blood Relations, Directions, clocks, calendars, Number, ranking & Time sequence test, Seating Arrangements, Data Sufficiency.

Reference Books

1   OBJECTIVE ENGLISH FOR COMPETITIVE EXAMINATION, HARI MOHAN PRASAD AND UMA SINHA, 2017, MC GRAW HILL.

2   55 ESSENTIAL TOOL FOR EVERY WRITER, ROY PETER CLARK, 2006, LITTLE BROWN AND COMPANY.

3   QUANTTAITIVE APTITUDE, ABHJITH GUPTA, 2017, MC GRAW HILL.

4   LOGICAL REASONING , ARUN SHARMA, 2006, MC GRAW HILL.

5   LOGICAL REASONING, PIYUSH BAHRADWAJ, 2006, ARIHANT PUBLICATIONS.

CADCOML1V1 - CAREER ADVANCEMENT:COMPETITIVE EXAM TRAINING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CADCOML1V1	CAREER ADVANCEMENT:COMPETITIVE EXAM TRAINING	CAD: COM	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Enhance critical thinking and problem-solving skills to analyze and solve complex problems effectively.	3	PO7
CO2	Apply strategic test-taking techniques to improve performance and manage exam-related stress.	3	PO7

Syllabus

Introduction to Critical Thinking: covering the definition, importance, and key components; Logical Reasoning: focusing on types of reasoning (deductive and inductive) and common logical fallacies; Data Interpretation: analyzing graphs, charts, and statistical information; and Problem-Solving Techniques: emphasizing creative problem-solving methods and structured frameworks.

Practice Sessions through case studies and group discussions. It also explores Understanding Exam Formats, providing an overview of common competitive exams such as GRE, GMAT, and UPSC, along with types of questions encountered. Students will learn Time Management Techniques for prioritizing questions and allocating time efficiently, alongside Effective Study Habits to create study schedules and utilize resources. The syllabus includes Stress Management Strategies, focusing on mindfulness and relaxation techniques, and concludes with Mock Exams and Feedback to assess performance and identify areas for improvement.

Reference Books

1 Critical Thinking: A Beginner's Guide, Gail McDonald, Springer, 2018.

2 The 7 Habits of Highly Effective People, Stephen R. Covey, Free Press, 2020.

CADCORL1V1 - CAREER ADVANCEMENT: TRAINING IN CORE DOMAIN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CADCORL1V1	CAREER ADVANCEMENT: TRAINING IN CORE DOMAIN	CAD: TICD	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply advanced domain-specific concepts and emerging trends to address industry challenges and innovations.	3	PO1, PO2
CO2	Apply advanced problem-solving and strategic decision-making techniques to manage complex projects within the core domain.	3	PO1, PO2

Syllabus

Core Concepts, theories, and frameworks of the specific domain (e.g., finance, IT, healthcare, engineering), Advanced Domain-Specific Tools, innovations and their impact on the core domain, Real-world examples of how new trends are being applied within the domain

Domain specific challenges, Practical exercises to resolve complex issues in the domain, best practices for managing projects within the domain, Case Studies and Simulations.

CADENTL1V1 - CAREER ADVANCEMENT:ENTREPRENEURIAL CAREER PATHWAY TRAINING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CADENTL1V1	CAREER ADVANCEMENT:ENTREPRENEURIAL CAREER PATHWAY TRAINING	CAD: ECPT	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	apply essential entrepreneurial qualities such as resilience, innovation, and risk-taking, enabling them to pursue entrepreneurial career paths in various contexts, including startups, corporate roles, and freelancing.	3	PO6, PO7
CO2	Develop the skills to recognize potential business opportunities, conduct thorough market research, and validate ideas by addressing customer needs and evaluating feasibility, preparing them to create sustainable business solutions.	3	PO6, PO7

Syllabus

Defining entrepreneurship: What it means to be an entrepreneur; The distinction between entrepreneurial and traditional career paths; The entrepreneurial mindset: resilience, risk-taking, innovation, and adaptability; Exploring entrepreneurial career pathways in startups, corporate environments, freelancing, and social ventures.

Spotting opportunities: How to find unmet needs and gaps in the market; Market research: Tools and techniques for understanding trends and customer needs; Idea validation: Testing the feasibility of your business idea; Problem-solving for innovation: Leveraging customer pain points and inefficiencies.

Reference Books

1. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, Eric Ries, 1st (2011), Crown Business.

2. The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company, Steve Blank, Bob Dorf, 2nd (2020), K&S Ranch Press.

3. Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers, Alexander Osterwalder, Yves Pigneur, 1st (2010), Wiley.

4. The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail, Clayton M. Christensen, 1st (1997), Harvard Business Review.

CADUPSL1V1 - CAREER ADVANCEMENT: UPSC-CIVIL SERVICES EXAM TRAINING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CADUPSL1V1	CAREER ADVANCEMENT: UPSC-CIVIL SERVICES EXAM TRAINING	CAD: UPSC	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the basics of Indian History and it\'s evolution	2	PO7
CO2	Understanding the basics of Indian Geography	2	PO7
CO3	Understanding the Evolution of Indian Constitution.	2	PO7
CO4	Understanding the evolution of Indian Economy	2	PO7

Syllabus

Ancient Indian History- IVC,Rig Vedic, Later Vedic, Buddhism, Jainism, Mahajanapadas, Mouryan Empire, Guptan Empire, Harshavardhana empire, Sangam Age.

Exploring The Physical and Social Geography of India: The Universe, Big Bang Theory, Solar system, Geological Time Scale, Earth\'s Interior, Earth\'s Magnetic Feild.

Indian Polity and Constitution: Sailent featuresof Indian constitution, Preamble, Fundamental RIghts, Directrive Principles of State Policy, Fundamental Duties , Indian Parliament.

Understanding India\'s Economy - Indian Economic Development, National Income, Public Finance, Indian Budget.

Reference Books

1   Indian Polity, M. Laxmikanth, 7, Tata Mc Graw Hill.

2   Indian Economy, Nitin Singhania, 5, Mc Graw Hill.

3   Ancient and Medieval India, Poonam Dalal Dahiya, 3, Mc Graw Hill.

4   Fundamentals of Physical Geography, Husain Majid, 5, Mc Graw Hill.

CRTCODL1V1 – CAMPUS RECRUITMENT: LOGIC BUILDING SKILLS TRAINING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CRTCODL1V1	CAMPUS RECRUITMENT: LOGIC BUILDING SKILLS TRAINING	CRT: LBST	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply logical principles and critical thinking skills to analyze and evaluate arguments, solve problems, and make informed decisions.	3	PO1
CO2	Identify various logical reasoning techniques to solve complex problems, identify patterns, and draw valid conclusions	3	PO1

Syllabus

Introduction to Logic and Critical Thinking: fundamentals of logic, including the concepts of statements, propositions, truth values, logical connectives (AND, OR, NOT, IF-THEN, IF-AND-ONLY-IF), truth tables, and logical equivalence. Students will learn to identify and analyze different types of arguments, including deductive and inductive reasoning. They will also develop critical thinking skills, such as evaluating evidence, identifying assumptions, and recognizing fallacies

Logical Reasoning and Problem-Solving: applying logical reasoning techniques to solve various types of problems. Students will learn about different problem-solving strategies, including problem decomposition, pattern recognition, working backward, and using analogies. They will practice solving logic puzzles, brain teasers, and real-world problems that require logical thinking. Additionally, students will explore the concepts of syllogisms, Venn diagrams, and conditional reasoning to enhance their problem-solving abilities

Reference Books

1   Introduction to Logic, Irving M. Copi, Carl Cohen, Victor Rodych, 2014, Routledge.

2   Critical Thinking, Richard Paul, Linda Elder, 2019, Pearson.

3   The Art of Logical Thinking; Or, The Laws of Reasoning, William Walker Atkinson, 2013, Public domain in the

4   Symbolic logic and The game of logic, Carroll, Lewis, 1958, Dover Publications.

CRTCSSL1V1 - CAMPUS RECRUITMENT: COMMUNICATION SKILLS TRAINING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CRTCSSL1V1	CAMPUS RECRUITMENT: COMMUNICATION SKILLS TRAINING	CRT: CST	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	apply knowledge of communication of different types and techniques while analyzing body language and tone to enhance overall communication effectiveness.	3	PO7
CO2	apply active listening and feedback techniques, and analyzing effective participation in group discussions, while exploring roles in teamwork and strategies for managing conflicts, alongside professional communication practices such as writing emails and conducting meetings.	3	PO7

Syllabus

Communication: Basics, significance, types, verbal & non-verbal communication techniques, effective speaking and presentation skills tone and pacing in verbal interactions

Interpersonal skills, listening skills, feedback techniques, group communication and dynamics, group discussion, conflict management in professional communication, E-mail writing, report writing, presentations, interview skills.

Reference Books

1. Business Communication: A Problem-Solving Approach, Louis E. Boone & David L. Kurtz, 3rd Edition, McGraw Hill Education.

2. The Complete Guide to Business School Presentations", Jennifer D. D. McDonald, 2nd Edition, Pearson.

3. Listening: The Forgotten Skill", Geoffrey M. Cohen, 1st Edition, University Press of America.

4. Business Communication: Process and Product", Mary Ellen Guffey & Dana Loewy, 8th Edition, Cengage Learning.

5. Effective Communication Skills" Author, John Adair, 2nd Edition, Pan Macmillan.

CRTCSSL2V2 - CAMPUS RECRUITMENT: SOFT SKILLS TRAINING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CRTCSSL2V2	CAMPUS RECRUITMENT: SOFT SKILLS TRAINING	CRT: SST	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	applyi and practice empathy, critical thinking, problem-solving, decision-making, effective communication, and interpersonal skills through real-life scenarios and interactive activities.	3	PO7
CO2	apply group discussion techniques, interview skills, and mock interviews through practical exercises, encouraging learners to practice and refine these skills in realistic settings.	3	PO7

Syllabus

Critical thinking, problem soving, decision making, communication skills, interpersonal skills

Grooming, group discussions, story narrations, interview skills, mock interviews

Reference Books

1   Personality Development and Soft Skills", Barun K. Mitra, 2nd Edition, Oxford University Press.

2   Communication Skills for Engineers", C. Muralikrishna & Sunita Mishra, 1st Edition, Pearson Education.

3   Developing Soft Skills", Robert L. Katz, 1st Edition, McGraw Hill Education.

CRTVQRL1V1 - CAMPUS RECRUITMENT: VERBAL APTITUDE TRAINING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CRTVQRL1V1	CAMPUS RECRUITMENT: VERBAL APTITUDE TRAINING	CRT: VAT	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	apply and practice grammatical concepts like sentence formation, identifying odd words, using one-word substitutions, while enhancing understanding of idioms, phrases, spellings, and structures.	3	PO7
CO2	apply concepts like paragraph formation, sentence completion, reading comprehension, sentence correction, and correcting jumbled sentences, while enhancing word selection and sentence structure accuracy.	3	PO7

Syllabus

Synonyms, Antonyms, odd words, parts of speech, idioms and phrases, one word substitutions, odd words, formation of sentences

sentence completion, sentence correction, jumbled sentences, paragraph formation, reading comprehension, and sentence selection

Reference Books

1 The Pearson Guide to Verbal Ability and Logical Reasoning for the CAT", Nishit K. Sinha, 2nd Edition, Pearson.

2 Objective General English", S.P. Bakshi, 3rd Edition, Arihant Publications.

3 English Grammar in Use", Raymond Murphy, 5th Edition, Cambridge University Press.

CRTVQRL2V2 - CAMPUS RECRUITMENT: QUANTITATIVE APTITUDE TRAINING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CRTVQRL2V2	CAMPUS RECRUITMENT: QUANTITATIVE APTITUDE TRAINING	CRT: QAT	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply principles of quantitative techniques to solve problems on Simple Equations, Simple & Compound Interest etc	3	PO7
CO2	Apply principles of quantitative techniques to solve problems on Divisibility, Functions, Surds & Indices etc	3	PO7

Syllabus

Simple Equations, Problem on Ages, Ratio & Proportion, Variation& Partnership, Percentages, Profit, Loss& Discounts, Simple & Compound Interest, Averages & Allegations or Mixtures

Numbers, Divisibility, Decimal Fractions, LCM & HCF, Simplification, Sequence, Series & Progressions, Linear Algebra, Quadratic Equations & Inequalities, Theory of Equations. Sets, Relations & Functions, Surds & Indices, Logarithms

Reference Books

1   Quantitative Aptitude by R.S. Agarwal, SCHAND Publications, R.S. Agarwal, 2021, SCHAND Publications.

2   A Modern Approach to Verbal Reasoning by R.S. Agarwal, SCHAND Publications, R.S. Agarwal, 2021, SCHAND Publications.

CRTVQRL3V3 - CAMPUS RECRUITMENT: REASONING APTITUDE TRAINING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CRTVQRL3V3	CAMPUS RECRUITMENT: REASONING APTITUDE TRAINING	CRT: RAT	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply principles of deductive logic to solve problems on syllogisms, Venn diagrams, etc	3	PO7
CO2	Apply principles of inductive logic to solve problems on assumptions and conclusions	3	PO7

Syllabus

Syllogism, Number& letter series, Number, letter & word Analogy, Odd man out, coding & decoding, Cubes & Dice, Logical Venn Diagrams

Statements & conclusions, statements & Arguments (Critical Reasoning), statements & Assumptions, logical connectives, Binary logic

Reference Books

1 A Modern Approach to Verbal Reasoning, R.S. Agarwal, 2022, SCHAND Publications.

2 Logical Reasoning for CAT, Arun Sharma, 2021, McGraw Hills.