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M.TECH. IN THERMAL ENGINEERING
COURSE STRUCTURE & SYLLABI

SEMESTER – I

S. No.	Course codes	Course Name	Category	Hours per week			Credits
				L	T	P	
1.	21D11102	Advanced Thermodynamics	PC	3	0	0	3
2.	21D11201	Advanced Heat & Mass Transfer	PC	3	0	0	3
3.		**Program Elective Course - I**					
	21D88101a	Advanced Turbo Machines					
	21D88101b	Advanced Refrigeration & Air- Conditioning					
	21D88101c	Design of Thermal Systems	PE	3	0	0	3
		Program Elective Course – II	PE	3	0	0	3
	21D11104a	Fuels & Combustion Technology					
	21D88102a	FEA in Thermal Engineering					
	21D88102b	Design of Heat Exchangers					
5.	21D88103	Thermal Engineering Laboratory	PC	0	0	4	2
6.	21D11205	Advanced Heat & Mass Transfer Laboratory	PC	0	0	4	2
7.	21DRM101	Research Methodology and IPR	MC	2	0	0	2
8.		**Audit Course – I**					
	21DAC101a	English for Research paper writing					
	21DAC101b	Disaster Management	AC	2	0	0	0
	21DAC101c	Sanskrit for Technical Knowledge					
Total							**18**

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SEMESTER – II

S.No.	Course codes	Course Name	Category	Hours per week			Credits
				L	T	P	
1.	21D88201	Advanced IC Engines	PC	3	0	0	3
2.	21D11204a	Computational Fluid Dynamics	PC	3	0	0	3
3.	21D88202a 21D88202b 21D88202c	**Program Elective Course – III** Instrumentation for Thermal Engineering Cryogenic Engineering Thermal & Nuclear Power Plants	PE	3	0	0	3
4.	21D88203a 21D88203b 21D88203c	**Program Elective Course – IV** Design of Thermal Systems Environmental Engineering & Pollution Control Alternative Energy Sources	PE	3	0	0	3
5.	21D88204	Simulation Laboratory	PC	0	0	4	2
6.	21D88205	Computational Fluid Dynamics Laboratory	PC	0	0	4	2
7.	21D88206	Technical seminar	PR	0	0	4	2
8.	21DAC201a 21DAC201b 21DAC201c	**Audit Course – II** Pedagogy Studies Stress Management for Yoga Personality Development through Life Enlightenment Skills	AC	2	0	0	0
Total							**18**

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SEMSTER - III

S.No.	Course codes	Course Name	Category	Hours per week			Credits
				L	T	P	
1.	21D88301a 21D88301b 21D88301c	**Program Elective Course – V** Optimization Techniques & Its Applications Jet Propulsion & Rocketry Aircraft and Space Propulsion	PE	3	0	0	3
2.	21DOE301c 21DOE301g 21DOE301h	**Open Elective** Business Analytics Internet Of Things Mechatronics	OE	3	0	0	3
3.	21D88302	Dissertation Phase – I	PR	0	0	20	10
4.	21D88303	Co-curricular Activities					2
	21D88304	**Total**					**18**

SEMESTER - IV

S.No.	Course codes	Course Name	Category	Hours per week			Credits
				L	T	P	
1.	21D88401	Dissertation Phase – II	PR	0	0	32	16
		Total					**16**

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Course Code	ADVANCED THERMODYNAMICS	L	T	P	C
21D11102		3	0	0	3
Semester		I			

Course Objectives: Student will be able to

- Solve theoretical and applied thermodynamics problems that are directly applicable to situations faced in research and industry.
- Significant emphasis is placed on the integration of recent thermodynamics-related research into the traditional resources in order to foster critical analysis of current work as it relates to fundamental principles.

Course Outcomes (CO): Student will be able to

- Describe and calculate thermodynamic properties of single-phase and multi-phase systems
- Apply the laws of statistical and classical thermodynamics to chemically reactive systems, kinetics, and combustion.
- Relate course principles to solve problems regarding gas turbines, combustion, refrigeration, and solar energy.
- Communicate engineering knowledge of thermodynamics through written and verbal means.

UNIT – I Lecture Hrs:9

AVAILABILITY ANALYSIS AND THERMODYNAMIC PROPERTY RELATIONS

Reversible work - availability - irreversibility and second – law efficiency for a closed system and steady – state control volume. Availability analysis of simple cycles. Thermodynamic potentials. Maxwell relations. Generalized relations for changes in entropy - internal energy and enthalpy - generalized relations for Cp and CV Clausius Clay person equation, Joule – Thomson coefficient. Bridgeman tables for thermodynamic relations.

UNIT – II Lecture Hrs:9

REAL GAS BEHAVIOUR AND MULTI – COMPONENT SYSTEMS

Different equations of state – fugacity – compressibility - principle of corresponding States - Use of generalized charts for enthalpy and entropy departure - fugacity coefficient, Lee – Kesler generalized three parameter tables. Fundamental property relations for systems of variable composition. Partial molar properties. Real gas mixtures - Ideal solution of real gases and liquid - activity - equilibrium in multi phase systems - Gibbs phase rule for non – reactive components

UNIT – III Lecture Hrs:9

CHEMICALTHERMODYNAMICSANDEQUILIBRIUM

Thermo chemistry-Firstlawanalysisofreactingsystems-Adiabaticflametemperature–entropy change of reacting systems- Second law analysis of reacting systems- Criterion for reaction equilibrium. Equilibriumconstantforgaseousmixtures-evaluationofequilibriumcomposition.

UNIT – IV Lecture Hrs:9

Analysis of vapour power & Vapour compression refrigeration cycles:

Rankine cycle with superheat, reheat and refrigeration - Exergy analysis, Super –critical and ultra-super-critical Rankine cycle.

Vapour compression refrigeration Systems, Analysis of vapour refrigeration systems, Commonly used refrigerants.

UNIT – V Lecture Hrs:

Analysis of Gas power cycles:

IC Engines : Air standard Otto, Diesel and Dual cycle

Gas turbines: Air standard Brayton cycle, Effect of reheat, inter cooling and regeneration **,** Combined gas and vapour power cycles.

Textbooks:

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COURSE STRUCTURE & SYLLABI

1. Kenneth Wark Jt. m, Advanced Thermodynamics for Engineers, McGrew – Hill Inc.,1995.
2. Bejan,A.,AdvancedEngineeringThermodynamics,JohnWileyandCons,1988.
3. Holman, J.P., Thermodynamics, Fourth Edition, McGraw–HillInc.,1988.
4. Fundamentals of Engineering Thermodynamics by V.Babu

Reference Books:

1. Smith,J.M.and VanNess., H.C.,Introductionto Chemical Engineering Thermodynamics, Fourth Edition, McGraw– HillInc.,1987.
2. Sonntag, R.E., and Van Wylen, G, Introduction to Thermodynamics, Classical andStatisticalThemodynamics,ThirdEdition,JohnWileyandSons, 1991.
3. Sears,F.W.andSalingerG.I.,Thermodynamics,KineticTheoryandStatisticalThermodynamics, ThirdEdition,NarosaPublishingHouse,NewDelhi,1993.
4. DeHotf, R.T., Thermodynamics in Materials Science, McGraw – Hill Inc., 1993.
   Rao,Y.V.C.Postulational and Statistical Thermodynamics, Allied Publisher Limited, NewDelhi,1999

Online Learning Resources:

1. https://nptel.ac.in/courses/103/103/103103162/
2. https://onlinecourses.nptel.ac.in/noc20_ch03/preview

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COURSE STRUCTURE & SYLLABI

Course Code	ADVANCED HEAT AND MASS TRANSFER	L	T	P	C
21D11201		3	0	0	3
	Semester	I			

Course Objectives: Student will be able to

- Develop the ability to use the heat transfer concepts for various applications like finned systems, turbulence flows, high speed flows.
- analyze the thermal analysis and sizing of heat exchangers and to learn the heat transfer coefficient for compact heat exchanges**.**
- Achieve an understanding of the basic concepts of phase change processes and mass transfer.

Course Outcomes (CO): Student will be able to

- Apply the law of thermodynamics to engines.

UNIT – I Lecture Hrs:

CONDUCTION AND RADIATION HEAT TRANSFER

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

UNIT – II Lecture Hrs:

TURBULENT FORCED CONVECTIVE HEAT TRANSFER

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

UNIT – III Lecture Hrs:

PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGER

Condensation with shears edge on bank of tubes - boiling – pool and flow boiling – heat exchanger –Є – NTU approach and design procedure - compact heat exchangers.

UNIT – IV Lecture Hrs:

NUMERICAL METHODS IN HEAT TRANSFER

Finite difference formulation of steady and transient heat conduction problems – discretization schemes – explicit - Crank Nicolson and fully implicit schemes - control volume formulation steady one-dimensional convection and diffusion problems - calculation of the flow field – SIMPLER Algorithm.

UNIT – V Lecture Hrs:

MASS TRANSFER AND ENGINE HEAT TRANSFER CORRELATION

Mass transfer - vaporization of droplets - combined heat and mass transfers - heat transfer correlations in various applications like I.C. engines - compressors and turbines.

Textbooks:

1. YunusA.Cengal, Heat and Mass Transfer – A practical Approach, 3rd edition, Tata McGraw - Hill, 2007.
2. Holman.J.P, Heat Transfer, Tata Mc Graw Hill, 2002.

Reference Books:

1. Ozisik. M.N., Heat Transfer – A Basic Approach, McGraw-Hill Co., 1985
2. Incropera F.P. and DeWitt. D.P., Fundamentals of Heat & Mass Transfer, John Wiley & Sons, 2002.

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3. Nag.P.K, Heat Transfer, Tata McGraw-Hill, 2002
4. Ghoshdastidar. P.S., Heat Transfer, Oxford University Press, 2004
5. Yadav, R., Heat and Mass Transfer, Central Publishing House, 1995.

Online Learning Resources:

1. https://nptel.ac.in/courses/112/101/112101097/

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COURSE STRUCTURE & SYLLABI

Course Code	ADVANCED TURBO MACHINES	L	T	P	C
21D88101a	Program Elective Course - I	3	0	0	3
	Semester	I			

Course Objectives: Student will be able to

- Develop the ability to use the turbo concepts for various applicants like steam nozzles, steam turbines etc.
- Achieve an understanding of the basic concepts of centrifugal, axial, rotary compressors and axial flow gas turbines.

Course Outcomes (CO): Student will be able to

- On successful completion of this course the student will be able to understand the concept of turbo machines and its applications.

UNIT – I — Lecture Hrs:9

Fundamentals of Turbo machines: Classification, Applications Thermodynamic analysis; Isentropic flow, Energy transfer; Efficiencies; static and Stagnation conditions; continuity equation; Euler's flow through variable cross sectional area; unsteady flow in turbo machines.

UNIT – II — Lecture Hrs:9

Steam Nozzles: Effect of back –pressure on the analysis; Design of nozzles.
Steam Turbines of C & C –D nozzles: Impulse Turbines: work done and velocity triangles; Efficiencies; Constant Reaction Blading; Design of blade passages, angles and height; Secondaryflow;leakagelosses;Thermodynamicanalysisofsteamturbines.

UNIT – III — Lecture Hrs:9

Gas Dynamics: Fundamentals thermodynamic concepts; Isentropic conditions; Mach numberandArea–Velocityrelation;Dynamicpressure;normalshockrelationsforperfectgas;supersonic flow, oblique shock waves ; normal shock recovery ; detached shocks ; Aerofoiltheory.
Centrifugal Compressor: Types; Velocity triangles and efficiencies; Blade passage design; Diffuser and pressure recovery; slip factor; stanitz and stodolas formulae; Effect of inlet mach number; Prewirl; performance

UNIT – IV — Lecture Hrs:9

Axial Flow Compressors: Flow analysis, work and velocity triangles; Efficiencies; Thermodynamic analysis; stage pressure rise ; Degree of reaction ; stage loading; general design, effect of velocity incidence; performance.
Cascade Analysis: Geometry and Terminology; Blade forces, Efficiency; losses; free and forced vortex blades.

UNIT – V — Lecture Hrs:8

Axial Flow Gas Turbines: Work done; velocity triangles and efficiencies; thermodynamic flowanalysis;degreeofreaction;Zweifelsrelation;Designcascadeanalysis–Soderberg–Hawthrone – ainley-correlations; secondary flow; Free-vortex blades; Blade angles for variable degree of reaction; Actuator disctheory;
Stresses in blades; Blade assembling; materials and cooling of blades; performance; Matching of compressor and turbine; off-design performance.

Textbooks:

Fundamentals of Turbo machines– Shephard
Practise on Turbo machines –G. Gopala krishnan & D. Prithviraj, SciTech Publishers, Chennai.
Elements of Gas Dynamics–Yahya

Reference Books:

Turbines, Compressors & Fans S. M. Yahya Tata McGraw Hill Co. Ltd 2nd edition, 2002
Principals of Turbo machines D. G. Shepherd The Macmillan Company 1964
Fluid Mechanics & Thermodynamics of Turbo machines S. L. Dixon Elsevier 2005

Online Learning Resources:

https://app.knovel.com/web/toc.v/cid:kpPTE00022/viewerType:toc//root_slug:principles-turbomachinery/url_slug:incompressible-flow?b-

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Course Code	ADVANCED REFRIGERATION AND AIRCONDITIONING (PE-I)	L	T	P	C
21D88101b		3	0	0	3
	Semester	I			

Course Objectives: Student will be able to

- To teach the students about the methods of Refrigeration and its types, Psychrometry and its priciples. Teaching the cycle analysis pertaining to various Refrigeration systems, Air-conditioning systems, cooling load calculations.

Course Outcomes:- Student will be able to

- Relate the performance of a vapour compression refrigeration cycles under specified inlet and outlet conditions. Identify the modifications required in an impossible reversed Carnot cycle to convert it into practical cycle for refrigeration applications.
- Demonstrate the working principle and coefficient of performance of a heat pump, heat engine and refrigerator Illustrate the working principles, limitations of practical aqua ammonia, LiBr-Water and Electrolux vapour absorption refrigeration systems.
- Analyze theoretical and practical steam jet refrigeration cycles with T-S and P-h charts by stating merits, limitations, etc. Discuss the measures to protect the ozone layer through global control, eventually elimination of production and utilization of ozone depleting substances. Classify the equipment used for the refrigeration, air conditioning purposes with suitable materials and refrigerant pairs.
- CO 4 Construct the sensible heat factor lines, locate alignment circle and SHF scale on a psychrometric chart for the cooling load calculations of air conditioning systems. Explain thermal comfort conditions with respect to effective temperature, relative humidity, etc. and their impact on human comfort, productivity and health.
- CO 5 Distinguish the equipment required for air conditioning systems, study the operating principles, safety controls employed in air conditioning systems. Assess the principles of psychrometry to calculate and design the air conditioning systems for particular purpose. Compare the various heat pump circuits for heating, cooling purposes with suitable industrial applications.

UNIT – I Lecture Hrs:09

Refrigerants:
Desirableproperties-thermodynamic-chemicalandtransportproperties-designationofrefrigerants inorganic, halo carbon refrigerants - secondary refrigerants - Properties of mixtures of refrigerants.
Ozone depletion potential and global warming potential–effect of refrigerants-alternative refrigerants.

UNIT – II Lecture Hrs:09

Vapour Compression Refrigeration: Analysis and Performance of Complete vapour compression Refrigeration system. Components of Vapour Compression RefrigerationSystem:Thecondensingunit–Evaporators–Expansionvalve;Refrigerants –Properties
–ODP and GWP.
Compound Compression: Need; Compounding with external inter cooling, Flash mixing Flash inter-cooling – liquid flash internal cooling – Multi Pressure-(Multistage)systems. Cascade System–Applications

UNIT – III Lecture Hrs:09

Vapor absorption Refrigeration system –Simple and modified aqua–ammonia system
– Representation on Enthalpy –Concentration diagram. Lithium– Bromide system Three fluid system–HCOP.
Air Refrigeration: Applications – Air Craft Refrigeration- Simple, Bootstrap, Regenerative and Reduced ambient systems – Problems based on different systems. Steam Jet refrigeration system: Representation on T-s and h-s diagrams – limitations and applications.
Unconventional Refrigeration systems: working principles of Thermo-electric Refrigeration–Vortex tube.

UNIT – IV Lecture Hrs:09

INTRODUCTION TO AIR CONDITIONING
Psychometric properties and processes, sensible and latent heat loads, characterization, need for

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ventilation, consideration of Infiltration, load concepts of RSHF, ASHF, ESHF and ADP; concept of human comfort and effective temperature, comfort air conditioning, industrial air conditioning and requirements, air conditioning load calculations

UNIT – V		Lecture Hrs:09

AIR CONDITIONING SYSTEMS

Classification of equipment, cooling, heating humidification and dehumidification, filters, grills and registers, deodorants, fans and blowers, heat pump, heat sources, different heat pump circuits, applications.

Textbooks:

1. Manohar Prasad, "Refrigeration and Air Conditioning‖ New Age International, 3rd Edition, 2015
2. S. C. Arora, Domkundwar, A Course in Refrigeration and Air-conditioning, Dhanpatrai Publications, Edition 2014.
3. S. N. Sapali, "Refrigeration and Air-conditioning", PHI Learning, 2 nd Edition, 2011.

Reference Books:

C. P. Arora, Refrigeration and Air Conditioning‖ Tata McGraw-Hill, 17th Edition, 2006.
Ananthanarayanan, Basic Refrigeration and Air Conditioning‖, Tata McGraw-Hill, 2015.
R.K.Rajput, A text of Refrigeration and Air Conditioning‖ S. K. Kataria& Sons, 3rd Edition, 2009.
P. L. Ballaney, Refrigeration and Air Conditioning‖ Khanna Publishers, 16th Edition, 2015.

Online Learning Resources:

http://ecoursesonline.iasri.res.in/course/resources.php?id=445

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Course Code	DESIGN OF THERMAL SYSTEMS	L	T	P	C
21D88101c	Program Elective Course - I	3	0	0	3
	Semester	I			

Course Objectives: Student will be able to

- Knowtheconceptsofheatexchangersandbasicdesignmethodsofheatexchangers
- Achieve an understanding of the basic concepts of Vaporizers, Evaporators and Re boilers, Extended Surfaces.

Course Outcomes (CO): Student will be able to

- Understand the concept of Heat exchanger design, extended surfaces and design of cooling towers etc.

UNIT – I Lecture Hrs:09

Classification of heat exchangers: Introduction, Recuperation and Regeneration–Tubular heat exchangers: double pipe, shell and tube heat exchanger, Plate heat exchangers, Gasketed plate heat exchanger, spiral plate heat exchanger, Lamella heat exchanger, extended surface heat exchanger, Plate fin, and Tubular fin.
Basic Design Methods of Heat Exchangers: Introduction, Basic equations in design, Overall heat transfer coefficient – LMTD method for heat exchanger analysis– parallel flow, counter flow, multi pass, cross flow heat exchanger design calculations.
Double Pipe Heat Exchanger: Film Coefficient for fluids in annulus, fouling factors, calorific temperature,averagefluidtemperature,thecalculationofdoublepipeexchanger, Double pipe exchangers in series, parallel arrangements.

UNIT – II Lecture Hrs:09

Shell and Tube Heat Exchangers: Tube layouts for exchangers, baffle Heat exchangers, calculation of shell and tube heat exchangers – shell side film coefficients, Shell side equivalent diameter, the true temperature difference in a 1-2 heat exchanger, influence of approach temperature on correction factor, shell side pressure drop, tube side pressure drop, Analysis of performanceof1-2heatexchanger, and design calculation of shell and tube heat exchangers. Flow arrangements for increased heat recovery, the calculations of2-4exchangers.
Condensation of single vapors: Calculation of a horizontal condenser, vertical condenser, De-super heater condenser, vertical condenser–sub-cooler, horizontal condenser–vertical reflux type condenser, condensation of steam.

UNIT – III Lecture Hrs:09

Vaporizers, Evaporators and Re boilers: Vaporizing processes, forced circulation vaporizing exchangers, natural circulation vaporizing exchangers, calculations of are boiler.

UNIT – IV Lecture Hrs:09

Extended Surfaces: Longitudinal fins, weighted fin efficiency curve, calculation of a double pipe fin efficiency curve, calculation of a double pipe finned exchanger, calculation of a longitudinal fin shell and tube exchanger.
Direct Contact Heat Exchanger: Cooling towers, relation between wet bulb and dew point temperatures, the Lewis number, and classification of cooling towers, cooling tower internals and the roll of fill, Heat balance

UNIT – V Lecture Hrs:09

Heat transfer by simultaneous diffusion and convection. Analysis of cooling tower requirements, Design of cooling towers, Determination of the number of diffusion units, calculation of cooling tower performance.

Textbooks:

1. Process Heat Transfer, D.Q.Kern, TMH.
2. Cooling Towers, J.D.Gurney
3. Heat Exchanger Design, A.P. Fraas and M.N. Ozisick. John Wiely& sons, NewYork.

Reference Books:

1. Cooling Towers, J.D.Gurney
2. Heat Exchanger Design, A.P.Fraas and M.N.Ozisick. John Wiely& sons, NewYork.

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Online Learning Resources:
• https://www.researchgate.net/publication/332109240_Design_of_thermal_systems

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Course Code	FUELS COMBUSTION & ENVIRONMENT	L	T	P	C
21D11104a	Program Elective Course - II	3	0	0	3
	Semester	I			

Course Objectives: Student will be able

To know the concepts of stoichiometry & kinetics for Solid, Liquid &Gaseous Fuels .
To achieve an understanding of the basic concepts of combustion equipments

Course Outcomes (CO): Student will be able to

- Understand the concept to fvarious fuels and combustion and effect of environment.

UNIT – I Lecture Hrs:9

CHARACTERIZATION

Fuels - Types and Characteristics of Fuels – Determination of Properties of Fuels – FuelsAnalysis-ProximateandUltimateAnalysis-MoistureDetermination-CalorificValue
Gross & Net Calorific Values - Calorimetry - DuLong's Formula for CV Estimation -Flue gas Analysis - Orsat Apparatus - Fuel & Ash Storage & Handling – Spontaneous Ignition Temperatures.

UNIT – II Lecture Hrs:9

SolidFuels

Types - Coal Family - Properties - Calorific Value - ROM, DMMF, DAF and Bone Dry Basis - Ranking - Bulk & Apparent Density - Storage - Wash ability - Coking & Caking Coals – Renewable Solid Fuels - Biomass - Wood Waste - Agro Fuels – Manufactured Solid Fuels.

LiquidFuels

Types - Sources - Petroleum Fractions - Classification - Refining - Properties of Liquid Fuels - Calorific Value, Specific Gravity, Flash & Fire Point, Octane Number, Cetane Number etc, -Alcohols-TarSandOil – Liquefaction of Solid Fuels.

UNIT – III Lecture Hrs:9

GASEOUSFUELS

Classification-Composition&Properties-EstimationofCalorificValue-GasCalorimeter. Rich & Lean Gas - Wobbe Index - Natural Gas - Dry & Wet Natural Gas -Stripped NG - Foul & Sweet NG - LPG - LNG - CNG - Methane - Producer Gas -Gasifiers - Water Gas - Town Gas - Coal Gasification - Gasification Efficiency - Non –Thermal Route-Biogas-Digesters -Reactions -Viability-Economics.

UNIT – IV Lecture Hrs:9

COMBUSTION:STOICHIOMETRY&KINETICS

Stoichiometry - Mass Basis & Volume Basis - Excess Air Calculation - Fuel & Flue Gas Compositions - Calculations -Rapid Methods - Combustion Processes -StationaryFlame - Surface or Flameless Combustion - Submerged Combustion - Pulsating & SlowCombustion Explosive Combustion. Mechanism of Combustion - Ignition & IgnitionEnergy -Spontaneous Combustion – Flame Propagation -Solid, Liquid& GaseousFuels Combustion - Flame Temperature - Theoretical, Adiabatic & Actual – Ignition Limits -Limits of Inflammability.

UNIT – V Lecture Hrs:9

COMBUSTIONEQUIPMENTS

Coal Burning Equipments - Types - Pulverized Coal Firing - Fluidized Bed Firing -FixedBed&RecycledBed-CycloneFiring-SpreaderStokers-VibratingGrateStokers - Sprinkler Stokers, Traveling Grate Stokers. Oil Burners - Vaporizing Burners, Atomizing Burners - Design of Burners. Gas Burners - Atmospheric Gas Burners – Air Aspiration Gas Burners - Burners Classification according to Flame Structures – Factors Affecting Burners& Combustion.

Textbooks:

SamirSarkar,Fuels&Combustion,2ndEdition,OrientLongman,1990
Bhatt,VoraStoichiometry,2ndEdition,TataMcgrawHill,1984
BlokhAG,HeatTransferin Steam BoilerFurnace,HemispherePublishingCorpn,1988.

Reference Books:

CivilDavies,CalculationsinFurnaceTechnology,PergamonPress,Oxford,1966
SharmaSP, MohanChander, Fuels&Combustion, TataMcgrawHill, 1984

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Online Learning Resources:
https://nptel.ac.in/courses/112/106/112106299/ https://nptel.ac.in/courses/103/105/103105110/

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ANANTHAPURAMU – 515 002 (A.P) INDIA

M.TECH. IN THERMAL ENGINEERING
COURSE STRUCTURE & SYLLABI

Course Code	FINITE ELEMENT ANALYSIS INTHERMAL ENGINEERING (PE-II)	L	T	P	C
21D88102a		3	0	0	3
Semester		I			

Course Objectives: Student will be able

- To providethefundamentalconceptsofthetheoryofthefiniteelementmethod
- To develop proficiency in the application of the finite element method (modeling, analysis, and interpretation of results) to realistic engineering problems through the use of a major commercial general-purpose finite element code.

Course Outcomes:- Student will be able

- To obtain an understanding of the fundamental theory of the FEA method;
- To develop the ability to generate the governing FE equations for systems governed by partial differential equations;
- To understand the use of the basic finite elements for structural applications using truss, beam, frame, and plane elements; and
- To understand the application and use of the FE method for heat transfer problems

UNIT – I Lecture Hrs:9

IntroductiontoFEM:basicconcepts,applicationofFEM,generaldescription,advantages of FEM, comparison of FEM with other methods : finite difference method,variationalmethod,GalerkinMethod,basicelementshapes,interpolationfunction.Virtual energy principle, treatment of boundary conditions, solution of system ofequations,basicequationsofelasticity,straindisplacementrelations.
1-D structural problems: axial bar element, stiffness matrix, load vector, temperature effects, quadratic shape function, analysis of trusses–plane truss and space truss elements.

UNIT – II Lecture Hrs:9

Analysis of beams, frames– Hermite shape functions, stiffness matrix, load vector problems, analysis.
2-Dproblems–CST,force terms, stiffness matrix and load vector, boundary conditions, Iso-parametric element, Quadric element, shape functions, Numerical Integration, 3-Dproblems–Tetrahedron element, Jacobian matrix, stiffness matrix.

UNIT – III Lecture Hrs:9

Axis Symmetric formulations, Finite Element Modeling- Triangular element, Problem modelling and Boundary conditions
Dynamic considerations, Dynamic equations, consistent mass matrix, Eigen values, Eigen vector, natural frequencies, mode shapes, modal analysis.

UNIT – IV Lecture Hrs:9

Scalar field problems– Generalized Heat Conduction Equation – Variation Principle –Boundary Conditions – Internal heat generation, heat flux and convection - 1-D SteadystateHeatconduction–Thermalloadvector-1-Dfinelement–Quadraticfinelements
ID unsteady state heat conduction–Thermal loadvector-2-Dsteady state heat conduction–Concepts of3D heat conduction
Finite Element Formulation of Torsion, Potential flow, seep age and fluid flow inducts.

UNIT – V Lecture Hrs:8

Computer Implementation : Pre-processing , mesh generation, elements connecting, boundary conditions, input of material and processing characteristics– solutions and post processing-overview and application packages

Textbooks:

Finite Element Methods,Alavala,PHI
Introduction to finite elements in engineering, Tirupathi K. Chandrapatla and Ashok D. Belagundu

Reference Books:

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2. An Introduction to Finite Element Methods, S.S. Rao, Pegamon, NewYork.
3. The Finite element method in Engineering science, O.C.Aienkowitz, Mc. GrawHill.
4. Concepts and applications of finite element analysis, Robert Cook
5. Finite Element Methods in Engineering Analysis, K.J.Bathe.
6. The finite element method in Heat transfer analysis – Lewis R.W ,Morgan.K,Thomas H.R. and Seetharaman K.N, John Wiley, 1994

Online Learning Resources:

- https://open.umich.edu/find/open-educational-resources/engineering/introduction-finite-element-methods

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M.TECH. IN THERMAL ENGINEERING
COURSE STRUCTURE & SYLLABI

Course Code	DESIGN OF HEAT EXCHANGERS	L	T	P	C
21D88102b	Program Elective Course - II	3	0	0	3
	Semester	I			

Course Objectives: Student will be able

- To learn the thermal and stress analysis on various parts of the heat exchangers
- To analyze the sizing and rating of the heat exchangers for various applications

Course Outcomes:- Student will be able to

- design the heat exchanger based on the information provided for a particular application and do the cost economic analysis

UNIT – I Lecture Hrs:9

FUNDAMENTALSOFHEATEXCHANGER
Temperature distribution and its implications types – shell and tube heat exchangers –regenerators and recuperators – analysis of heat exchangers – LMTD and effectiveness method.

UNIT – II Lecture Hrs:9

FLOWANDSTRESSANALYSIS
Effect of turbulence – friction factor – pressure loss – stress in tubes – header sheets and pressure vessels– thermal stresses, shear stresses-types of failures.

UNIT – III Lecture Hrs:9

DESIGNASPECTS
Heat transfer and pressure loss – flow configuration – effect of baffles – effect of deviations from ideality – design of doublepipe-finnedtube-shellandtubeheatexchangers-simulationofheatexchangers.

UNIT – IV Lecture Hrs:8

COMPACTANDPLATEHEATEXCHANGERS
Types–meritsanddemerits–designofcompactheatexchangers,plateheatexchangers
Performance influencing parameters-limitations.

UNIT – V Lecture Hrs:8

CONDENSERSANDCOOLINGTOWERS
Designofsurfaceandevaporativecondensers–coolingtower–performancecharacteristics.

Textbooks:

1.SadikKakacandHongtanLiu,HeatExchangersSelection,RatingandThermalDesign,CRC Press,2002

Reference Books:

Arthur. PFrass,Heat Exchanger Design, JohnWiley&Sons,1988.
Taborek.T, Hewitt.G.F and Afgan.N,Heat Exchangers, Theoryand Practice, McGraw- HillBookCo.1980.
Hewitt.G.F,Shires.G.L and Bott.T.R,Process Heat Transfer,CRCPress,1994.

Online Learning Resources:

https://nptel.ac.in/courses/112/105/112105248/

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M.TECH. IN THERMAL ENGINEERING
COURSE STRUCTURE & SYLLABI

Course Code	THERMAL SCIENCE LABORATORY	L	T	P	C
21D88103		0	0	4	2
	Semester	I			

Course Objectives: Student will be able

- To become familiar with the instruments and equipment for the measurement of exhaust emissions.
- To become familiar with heat transfer measurement.
- To become familiar with solar parameters.

Course Outcomes (CO): Student will be able to

- Become familiar with the measurement equipments and procedure for exhaust emission, heat transfer and solar parameters

List of Experiments:

1. To find the exhaust emissions of an automobile (HC, CO, NOX) .
2. Analysis of exhaust gases on IC engine.
3. Combustion analysis of CI engine
4. To find Octane number of given blends of fuel.
5. Performance analysis of Heat Pipe
6. Two Phase flow heat transfer estimation.
7. To estimate the COP of a vapour compression refrigeration system (Refrigerator).
8. To find the solar flat plate collector efficiency.
9. To find direct solar incident flux absorbed by using Pyranometer or concentratic parabolic collector.
10. Case study for energy audit.

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M.TECH. IN THERMAL ENGINEERING
COURSE STRUCTURE & SYLLABI

Course Code	ADVANCED HEAT AND MASS TRANSFER LABORATORY	L	T	P	C
21D11205		0	0	4	2
	Semester	II			

Course Objectives: Student will be able to

- Become familiar with the instruments and equipment for the measurement of thermal conductivity, heat transfer coefficient and other heat transfer parameters.

Course Outcomes (CO): Student will be able to

- Become familiar with the measurement equipments and procedure for the measurement of thermal conductivity, heat transfer coefficient and other heat transfer parameters.

List of Experiments:

1. Thermal conductivity of insulating powder material through Concentric Sphere apparatus. 2. Thermal conductivity of insulating material through lagged pipe apparatus
3. Overall heat transfer co-efficient through Composite Slab Apparatus
4. Thermal Conductivity of metal (conductor).
5. Heat transfer in pin-fin
6. Experiment on Transient Heat Conduction
7. Heat transfer coefficient in forced convection.
8. Heat transfer coefficient in natural convection
9. Experiment on Parallel and counter flow heat exchanger.
10. Emissivity of a gray body through Emissivity apparatus.
11. Experiment on Stefan Boltzman Apparatus.
12. Heat transfer in drop and film wise condensation.
13. Experiment on Critical Heat flux apparatus.
14. Study of heat pipe and its demonstration.
15. Study of Two – Phase flow

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M.TECH. IN THERMAL ENGINEERING
COURSE STRUCTURE & SYLLABI

Course Code	RESEARCH METHODOLOGY AND IPR	L	T	P	C
21DRM101		2	0	0	2
	Semester	I			

Course Objectives:

- Identify an appropriate research problem in their interesting domain.
- Understand ethical issues understand the Preparation of a research project thesis report.
- Understand the Preparation of a research project thesis report
- Understand the law of patent and copyrights.
- Understand the Adequate knowledge on IPR

Course Outcomes (CO): Student will be able to

- Analyze research related information
- Follow research ethics
- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
- Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
- Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

UNIT - I		Lecture Hrs:

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, scope, and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT - II		Lecture Hrs:

Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

UNIT - III		Lecture Hrs:

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT - IV		Lecture Hrs:

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT - V		

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Textbooks:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"

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Reference Books:

1. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
3. Mayall, "Industrial Design", McGraw Hill, 1992.
4. Niebel, "Product Design", McGraw Hill, 1974.
5. Asimov, "Introduction to Design", Prentice Hall, 1962.
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.

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M.TECH. IN THERMAL ENGINEERING
COURSE STRUCTURE & SYLLABI

Course Code	ADVANCED IC ENGINES	L	T	P	C
21D88201		3	0	0	3
	Semester	II			

Course Objectives: Student will be able

To understand the underlying principles of operation of different IC Engines and components.
To provide knowledge on pollutant formation, control, alternate fuel etc.

Course Outcomes:- Student will be able to

compare the operations of different IC Engine and components and can evaluate the pollutant formation, control, alternatefuel

UNIT – I		Lecture Hrs:9

SPARKIGNITIONENGINES
SparkignitionEnginemixturerequirements–Fuel–Injectionsystems–Monopoint, Multi point injection, Direct injection – Stages of combustion – Normal and abnormal combustion –factors affecting knock– Combustion chambers.

UNIT – II		Lecture Hrs:9

COMPRESSIONIGNITIONENGINES
States of combustion in C.I. Engine–Direct and indirect injection systems–Combustion chambers – Fuel spray behaviour – spray structure, spray penetration and evaporation–air motion–Introduction to Turbo charging.

UNIT – III		Lecture Hrs:9

POLLUTANTFORMATIONANDCONTROL
Pollutant– Sources – Formation of carbon monoxide, Un burnt hydro carbon, NOx, Smoke and Particulatematter–MethodsofcontrollingEmissions–CatalyticconvertersandParticulate Traps – Methods of measurements and Introduction to emission norms and Driving cycles.

UNIT – IV		Lecture Hrs:9

ALTERNATIVE FUELS
Alcohol, Hydrogen, Natural Gas and Liquefied Petroleum Gas- Properties, Suitability, Merits and Demerits as fuels, Engine Modifications.

UNIT – V		Lecture Hrs:8

RECENTTRENDS
Lean Burn Engines – Stratified charge Engines – homogeneous charge compression ignition engines–Plasma Ignition–Measurement techniques–laser Doppler, Anemometry.

Textbooks:

1.K.K.Ramalingam, Internal Combustion Engine Fundamentals, ScitechPublications,2002.

Reference Books:

1. R.B.Mathur and R.P.Sharma, Internal combustion Engines.
2. V.Ganesan,Int. Combustion Engines,IIEdition, TMH,2002.
3. Duffy Smith, auto fuel Systems, The Good Heart Willox Company,Inc., 198.

Online Learning Resources:

1. https://ocw.mit.edu/courses/mechanical-engineering/2-61-internal-combustion-engines-spring-2017/

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M.TECH. IN THERMAL ENGINEERING
COURSE STRUCTURE & SYLLABI

Course Code	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
21D11204a		3	0	0	3
	Semester	II			

Course Objectives: Student will be able

- To develop finite difference and finite volume discredited forms of the CFD equations.
- To formulate explicit & implicit algorithms for solving the Euler Eqns & Navier Stokes Eqns.

Course Outcomes:- Student will be able to

- Formulate explicit &implicit algorithms for solving the Euler Eqns & Navier Stokes Eqns.

UNIT – I Lecture Hrs:9

GOVERNING DIFFERENTIAL EQUATION AND FINITE DIFFERENCE METHOD

Classification, Initial and Boundary conditions, Initial and Boundary value problems. Finite difference method, Central, Forward, Backward difference, Uniform and non-uniform Grids, Numerica lErrors, Grid Independence Test.

UNIT – II Lecture Hrs:9

CONDUCTIONHEATTRANSFER

Steady one-dimensional conduction, Two and Three dimensional steady state problems, Transient one-dimensional problem,Two- dimensional Transient Problems.

UNIT – III Lecture Hrs:9

INCOMPRESSIBLEFLUIDFLOW

Governing Equations, Stream Function – Verticity method, Determination of pressure for viscous flow, SIMPLE Procedure of Patankar and spalding, Computation of Boundary layer flow, Finite difference approach.

UNIT – IV Lecture Hrs:8

CONVECTIONHEATTRANSFERANDFEM

Steady One-Dimensional and Two-Dimensional Convection – Diffusion, Unsteady one-dimensionalconvection–Diffusion,Unsteadytwo-dimensionalconvection–Diffusion
- Introduction to finite element method – Solution of steady heat conduction by FEM – In compressible flow – Simulation by FEM

UNIT – V Lecture Hrs:9

TURBULENCEMODELS

Algebraic Models – One equation model, K - Models, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes.

Textbooks:

Muralidhar,K.,and Sundararajan,T.,"Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi,1995.
Ghoshdasdidar,P.S.,"Computer Simulation of flow and heat transfer"Tata Mc Graw Hill Publishing CompanyLtd.,1998.

Reference Books:

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1. Subas,V.Patankar"Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 1980.
2. Taylor,CandHughes,J.B."FiniteElementProgrammingoftheNavierStockEquation", Pineridge PressLimited,U.K.,1981.
3. Anderson, D.A.,Tannehill,J.I. ,and Pletcher,R.H., "Computational fluid Mechanic and Heat Transfer" Hemisphere Publishing Corporation, Newyork,USA,1984.
4. Fletcher, C.A.J."Computational Techniques for Fluid Dynamics 1"Fundamental and General Techniques, Springer–Verlag,1987.
5. Fletcher, C.A.J."Computational Techniques for Fluid Dynamics 2" Specific Techniques for Different Flow Categories, Springer– Verlag,1987.
6. Bose,T.X., "Numerical Fluid Dynamics"Narosa Publishing House,1997.

Online Learning Resources:

https://nptel.ac.in/courses/112/107/112107079/
https://www.cfd-online.com/Links/education.html

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M.TECH. IN THERMAL ENGINEERING
COURSE STRUCTURE & SYLLABI

Course Code	INSTRUMENTATION FOR THERMAL ENGINEERING	L	T	P	C
21D88202a	Program Elective Course - III	3	0	0	3
	Semester	II			

Course Objectives: Student will be able

- To provide knowledge on various measuring instruments.
- To provide knowledge on advance measurement techniques.
- To understand the various steps involved in error analysis and uncertainty analysis.

Course Outcomes:- Student will be able to

Understand the various steps involved in error analysis and uncertainty analysis.

UNIT – I Lecture Hrs:9

MEASURMENTCHARACTERISTICS
Instrument Classification, Characteristics of Instruments–Static and dynamic, experimental error analysis, Systematic and random errors, Statistical analysis, Uncertainty, Experimental planning and selection of measuring instruments, Reliability of instruments.

UNIT – II Lecture Hrs:9

MICROPROCESSORSANDCOMPUTERSINMEASURMENT
Data logging and acquisition – use of sensors for error reduction, elements of micro computer inter facing, intelligent instruments in use.

UNIT – III Lecture Hrs:9

MEASURMENTOFPHYSICALQUANTITIES
Measurement of thermo-physical properties, instruments for measuring temperature, pressure and flow, use of sensors for physical variables.

UNIT – IV Lecture Hrs:9

ADVANCEMEASURMENTTECHNIQUES
Shadow graph, Schlieren, Interferometer, Laser Doppler Anemometer, Hot wire Anemometer, heat flux sensors, Telemetry in measurement.

UNIT – V Lecture Hrs:9

MEASURMENTANALYSERS
Orsat apparatus, Gas Analysers, Smoke meters, gas chromatography, spectrometry.

Textbooks:

Holman,J.P., Experimental methods for engineers,McGraw-Hill,1988.
Barnery, Intelligent Instrumentation, Prentice Hall of India,1988.
Prebrashensky,V.,MeasurementsandInstrumentationinHeatEngineering,Vol.1and2,MIR Publishers,1980.

Reference Books:

1. Raman,C.S.,Sharma,G.R.,Mani,V.S.V.,InstrumentationDevicesandSystems,TataMcGraw-Hill,NewDelhi,1983.
2. Holman, J.P.,Experimentalmethodsforengineers,McGraw-Hill,1958.
3. Barney,IntelligentInstrumentation,PrenticeHallofIndia,1988
4. Prebrashensky. V., Measurement and Instrumentation inHeatEngineering,Vol.1 andMIRPublishers,1980.
5. Raman,C.S.Sharma,G.R.,Mani,V.S.V.,InstrumentationDevicesandSystems,
6. Tata Mc Graw-Hill, New Delhi,1983.
7. Doeblin, Measurement System Application and Design, McGraw-Hill,1978.
8. Morris.A.S,PrinciplesofMeasurementsandInstrumentationPrenticeHallofIndia,1998

Online Learning Resources:

1. https://mech.at.ua/HolmanICS.pdf

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M.TECH. IN THERMAL ENGINEERING
COURSE STRUCTURE & SYLLABI

Course Code	CRYOGENIC ENGINEERING	L	T	P	C
21D88202b	Program Elective Course - III	3	0	0	3
	Semester	II			

Course Objectives: Student will be able to

- Impart basic knowledge of low temperature generation, difficulties in maintain in glow temperature and solutions
- Understand applications of cryogenic refrigeration
- Understand storage of cryogenic liquids and equipments, instruments used

Course Outcomes:- Student will be able to

- Upon the completion of the course student will be able to understand the use of cryogenic systems, real-time difficulties in storing cryogenic liquids

UNIT – I Lecture Hrs:9

INTRODUCTION
Insight on Cryogenics, Properties of Cryogenic fluids, Material properties at Cryogenic Temperatures. Applications of Cryogenics in Space Programs, Superconductivity, Cryo Metallurgy, Medical applications.

UNIT – II Lecture Hrs:9

LIQUEFACTIONCYCLES
Carnot Liquefaction Cycle, F.O.M. and Yield of Liquefaction Cycles. Inversion Curve – JouleThomsonEffect.LindeHampsonCycle,PrecooledLindeHampsonCycle,Claudes Cycle Dual Cycle, Ortho-Para hydrogen conversion, Eollins cycle, Simpson cycle, Critical Components in Liquefaction Systems

UNIT – III Lecture Hrs:9

SEPARATIONOFCRYOGENICGASES
Binary Mixtures,T-C and H-C Diagrams, Principle of Rectification, Rectification Column Analysis-Mc Cabe Thiele Method. Adsorption Systems for purification.

UNIT – IV Lecture Hrs:9

CRYOGENICREFRIGERATORS
J.T.Cryocoolers,StirlingCycleRefrigerators,G.M.Cryocoolers,PulseTubeRefrigerators
Regenerators used in Cryogenic Refrigerators, Dilution refrigerators, Magnetic Refrigerators

UNIT – V Lecture Hrs:09

HANDLINGOFCRYOGENS
CryogenicDewar,CryogenicTransferLines.InsulationsusedinCryogenicSystems,InstrumentationtomeasureFlow,LevelandTemperature

Textbooks:

1.KlausD.TimmerhausandThomasM.Flynn,CryogenicProcessEngineering,PlenumPress,NewYork,1989
2. RandallF. Barron, Cryogenic Systems, McGraw-Hill,1985.

Reference Books:

ScottR.B., CryogenicEngineering,VanNostrandandCo.,1962.
HeraldWeinstock,CryogenicTechnology,1969.
RobertW.Vance,CryogenicTechnology,Johnwiley&Sons,Inc.,NewYork,London.

Web References :

www.nasa.gov
www.cryogenicsociety.org/
www.iifiir.org/
www.linde.com
www.airliquide.com/
www.cern.ch
www.nist.gov

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M.TECH. IN THERMAL ENGINEERING
COURSE STRUCTURE & SYLLABI

Course Code	**THERMAL AND NUCLEAR POWER PLANTS**	**L**	**T**	**P**	**C**
21D88202c	**Program Elective Course - III**	**3**	**0**	**0**	**3**
	Semester	**II**			

Course Objectives: Student will be able to

Impart knowledge about various components and equipments used in a thermal and nuclear power plant, their maintenance and performance analysis and economic analysis.

Course Outcomes:- Student will be able to

Understanding about the components used, their operation and maintenance and performance of it.

UNIT – I Lecture Hrs:9

Introduction – Sources of Energy, types of Power Plants, Direct Energy Conversion System, Energy Sources in India, Recent developments in Power Generation. Combustion of Coal, Volumetric Analysis, Gravimetric Analysis, Flue gas Analysis.
Steam Power Plants: Introduction – General Layout of Steam Power Plant, Modern Coal-fired Steam Power Plants, Power Plant cycles, Fuel handling, Combustion Equipment, Ash handling, Dust Collectors.

UNIT – II Lecture Hrs:9

Steam Generators: Types, Accessories, Feed water heaters, Performance of Boilers, Water Treatment, Cooling Towers, Steam Turbines, Compounding of Turbines, Steam Condensers, Jet and Surface Condensers.
Gas Turbine Power Plant: Cogeneration, Combined cycle Power Plants, Analysis, Waste-Heat Recovery, IGCC Power Plants, Fluidized Bed Combustion – Advantages &Disadvantages.

UNIT – III Lecture Hrs:9

Nuclear Power Plants: Nuclear Physics, Nuclear Reactors, Classification – Types of Reactors, Site Selection, Methods of enriching Uranium, Applications of Nuclear Power Plants.
Nuclear Power Plants Safety: By-Products of Nuclear Power Generation, Economics of Nuclear Power Plants, Nuclear Power Plants in India, Future of Nuclear Power.

UNIT – IV Lecture Hrs:9

Economics of Power Generation: Factors affecting the economics, Load Factor, Utilization factor, Performance and Operating Characteristics of Power Plants. Economic Load Sharing, Depreciation, Energy Rates, Criteria for Optimum Loading, Specific Economic energy problems.

UNIT – V Lecture Hrs:9

Power Plant Instrumentation: Classification, Pressure measuring instruments, Temperature measurement and Flow measurement. Analysis of Combustion gases, Pollution–Types, Methods of Control.

Textbooks:

1. Power Plant Technology, El Wakil.
2. Power Plant Engineering, P.C. Sharma, Kotaria Publications.

Reference Books:

1. Power Plant Engineering, P.K. Nag, TMH.

Online Learning Resources:

1. https://nptel.ac.in/courses/112/103/112103243/

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M.TECH. IN THERMAL ENGINEERING
COURSE STRUCTURE & SYLLABI

Course Code	DESIGN OF THERMAL SYSTEMS Program Elective Course - IV	L	T	P	C
21D88203a		3	0	0	3
	Semester	II			

Course Objectives: Student will be able

- To learn basic principles underlying piping, pumping, heat exchangers; modeling and optimization in design of thermal systems.
- To develop representational modes of real processes and systems.
- To optimization concerning design of thermal systems.

Course Outcomes:- Student will be able to

Understand modeling and optimization of Thermal systems.

UNIT – I	Lecture Hrs:9

DESIGNCONCEPTS
Design Principles, Workable Systems, Optimal Systems, Matching of System Components, Economic Analysis, Depreciation, Gradient Present Worth factor.

UNIT – II	Lecture Hrs:9

MATHEMATICALMODELLING
Equation Fitting, Nomography , Empirical Equation , Regression Analysis , Different Modes of Mathematical Models, Selection, Computer Programmes for Models.

UNIT – III	Lecture Hrs:9

MODELLINGTHERMALEQUIPMENTS
Modelling Heat Exchangers, Evaporators, Condensers, Absorption and Rectification Columns Compressors, Pumps, Simulation Studies , Information Flow Diagram ,Solution Procedures.

UNIT – IV	Lecture Hrs:9

OPTIMIZATION
Modelling Heat Exchangers, Evaporators, Condensers, Absorption and Rectification Columns Compressors, Pumps, Simulation Studies , Information Flow Diagram, Solution Procedures.

UNIT – V	Lecture Hrs:9

DYNAMICBEHAVIOUR
Steady state Simulation, Laplace Transformation, Feedback Control Loops, Stability Analysis, Non-Linearities.

Textbooks:

Stoecker W. F.,Design of Thermal Systems, Mc Graw Hill Edition,1989.
Bejan A., George T satsaronis , Michael J. Moran , Thermal Design and Optimization,Wiley,1996.

Reference Books:

1. Kapur J.N., Mathematical Modelling,Wiley Eastern Ltd, NewYork,1989.
2. Yogesh Jaluria, Design and Optimization of Thermal Systems, CRCPress, 2007.
3.RaoS. S., Engineering Optimization Theory and Practice, New Age Publishers, 2000

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ENGINEERING & TECHNOLOGY PG (M.TECH.) COURSES
PROPOSED COURSE STRUCTURE

Course Code	ENVIRONMENTAL ENGINEERING AND POLLUTION CONTROL (PE-IV)	L	T	P	C
21D88203b		3	0	0	3
	Semester	II			

Course Objectives: Student will be able

- To impart knowledge on the atmosphere and its present condition, global warming and eco legislations.
- To detail on the sources of air, water and noise pollution and possible solutions for mitigating their degradation.
- To elaborate on the technologies available for generating energy from waste.

Course Outcomes:- Student will be able to

- Understand detail on the sources of air, water and noise pollution and possible solutions for mitigating their degradation.

UNIT – I — Lecture Hrs:9

INTRODUCTION

Global atmospheric change – green house effect – Ozone depletion - natural cycles -mass and energy transfer – material balance – environmental chemistry and biology –impacts – environmental. Legislations. Pollutants - sources and effect – air pollutionmeteorology–atmosphericdispersion– indoorairquality-controlmethodsandequipments-issuesinairpollutioncontrol– air sampling and measurement.

UNIT – II — Lecture Hrs:9

AIRPOLLUTIONCONTROL

Air Pollution Control equipment for particulate matter & gaseous pollutants– gravity settling chambers, centrifugal collectors, wet collectors, fabric filters, electrostatic precipitator (ESP). –Adsorption, Absorption, Scrubbers, Condensation and Combustion.

UNIT – III — Lecture Hrs:9

WATERPOLLUTION

Water resources - water pollutants - characteristics – quality - water treatment systems –waste water treatment- treatment, utilization and disposal of sludge- monitoring compliance with standards.

UNIT – IV — Lecture Hrs:9

WASTEMANAGEMENT

Sources and Classification–Solid waste–Hazardous waste-Characteristics– Collection and Transportation - Disposal – Processing and Energy Recovery – Waste minimization.

UNIT – V — Lecture Hrs:9

OTHERTYPESOFPOLLUTIONFROM INDUSTRIES

Noise pollution and its impact - oil pollution - pesticides - instrumentation for pollutioncontrol– waterpollutionfromtanneriesandotherindustriesandtheircontrol– environmentimpactassessmentforvariousprojects –case studies.

Textbooks:

1.G.Masters (2003):Introduction to Environmental Engineering and Science Prentice Hall of India Pvt Ltd, NewDelhi.
2.H.S.Peavy, D.R, .Rowe, G.Tchobanoglous (1985): Environmental Engineering Mc Graw - Hill Book Compan, NewYork.

Reference Books:

1.H.Ludwig, W.Evans (1991): Manual of Environmental Technology in Developing Countries, International Book Company, Absecon Highlands, N.J.
2.ArcadioP Sincero and G. A.Sincero, (2002): Environmental Engineering–A Design Apporach, Prentice Hall of India Pvt Ltd, New Delhi

Online Learning Resources:

https://authors.library.caltech.edu

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ENGINEERING & TECHNOLOGY PG (M.TECH.) COURSES
PROPOSED COURSE STRUCTURE

Course Code	ALTERNATIVE ENERGY SOURCES	L	T	P	C
21D88203c	Program Elective Course - IV	3	0	0	3
	Semester	II			

Course Objectives: Student will be able

- To create awareness about the availability of various non-conventional energy sources, their conversion technology.

Course Outcomes:-

- Students will get an idea about the availability of Non- conventional energy sources, their conversion technologies, utilization, etc.

UNIT – I Lecture Hrs:9

Solar Energy
Sun as Source of Energy, Availability of Solar Energy, Nature of Solar Energy, Solar Energy& Environment. Various Methods of using solar energy–Photo thermal, Photovoltaic, Photosynthesis, Present & Future Scope of Solar energy. Hybrid wind energy systems - wind + diesel power, wind + conventional grid, wind +Photovoltaic system etc.

UNIT – II Lecture Hrs:9

Biomass:
Generation and utilization, Properties of biomass, Agriculture Crop & Forestry residues used as fuels. Biochemical and Thermo –chemical Conversion, Combustion, Gasification, Biomass gasifies and types etc. Applications of Gasifies to thermal power and Engines, Biomass as a decentralized power generation source for villages Concept of Bio-energy: Photosynthesis process, Bio-fuels, Biomass resources Bio based chemicals and materials Thermo-chemical Conversion: Pyrolysis, Combustion, Gasification, and Liquefaction. Bio-Chemical Conversion: Aerobic and An aerobic conversion, Fermentation etc. Bio-fuels: Importance, Production and applications. Bio-fuels: Types of Bio-fuels, Production processes and technologies, Bio fuel applications, Ethanol as a fuel for I.C. engines, Relevance with Indian Economy. Bio-based Chemicals and Materials: Commercial and Industrial Products, Biomass, Feed stocks, Chemicals, Plastics, Fibers etc.

UNIT – III Lecture Hrs:9

Bio methanation: Importance of biogas technology, Different Types of Biogas Plants. Aerobic and an aerobic bio conversion processes various substrates used to produce Biogas (cow dung, human and other agricultural waste, municipal waste etc.) Individual and community biogas operated engines and their use. Removal of CO2 and H2O, Application of Biogas in domestic, industry and vehicles. Bio-hydrogen production. Isolation of methane from Biogas and packing and its utilization.

UNIT – IV Lecture Hrs:9

Wind Energy: Basics & Power Analysis, Wind resource assessment, Power ConversionTechnologiesandapplications,WindPowerestimationtechniques,PrinciplesofAerodynamicsofwindturbineblade,Variousaspectsofwindturbine design,

UNIT – V Lecture Hrs:9

Wind Turbine Generators: Induction, Synchronous machine, constant V&F and variable V & F generations, Reactive power compensation. Site Selection, Concept of wind form & project cycle, Cost economics & viability of wind farm,

Textbooks:

Biomass Renegerable Energy–D.O.halland R.P.Overeed (John Wiley and Sons, Newyork,1987)
Biomass for energy in the developing countries–D.O.Hall ,G.W. barnard and P.A.Moss (Pergamon Press Ltd.1982)

Reference Books:

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ENGINEERING & TECHNOLOGY PG (M.TECH.) COURSES
PROPOSED COURSE STRUCTURE

Thermo chemical processing of Biomass, Bridgurater AV. Biomass as Fuel–L.P. White (Academicpress1981) Biomass Gasification Principles and Technology, Energy technology review No.67,- T.B. Read (Noyes Data Corp.,1981) Wind energy Conversion Systems– Freris L.L. (PrenticeHall1990) Wind Turbine Technology: Fundamental concepts of wind turbine technology Spera D.A. (ASME Press, NY,1994)
Online Learning Resources:
https://nptel.ac.in/courses/121/106/121106014/ https://www.edx.org/course/sustainable-energy

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ENGINEERING & TECHNOLOGY PG (M.TECH.) COURSES
PROPOSED COURSE STRUCTURE

Course Code	**SIMULATION LABORATORY**	**L**	**T**	**P**	**C**
21D88204		**0**	**0**	**4**	**2**
Semester		**II**			

Course Objectives: Student will be able

- To identify the behavior of analytical models introduced in lecture to the actual behavior of real fluid flows.
- To explain the standard measurement techniques of fluid mechanics and their applications.
- To illustrate the students with the components and working principles of the Hydraulic machines- different types of Turbines, Pumps, and other miscellaneous hydraulics machines.
- To analyze the laboratory measurements and to document the results in an appropriate format.

Course Outcomes:- Student will be able to

- Describe the measurement techniques of fluid mechanics and its appropriate application.
- Interpret the results obtained in the laboratory for various experiments.
- Compare the results of analytical models introduced in lecture to the actual behavior of real fluid flows and draw correct and sustainable conclusions.
- Write a technical laboratory

List of Experiments :-

1. Jet impact on flat and curved surfaces
2. Measurement of drag on a circular cylinder in high Reynolds number flow
3. Energy loss measurements in subcritical and supercritical open channel flow
4. Measurement of fluid viscosity
5. Determination of friction factor as a function of Reynolds number in pipe flow
6. Studying laminar-turbulent transition for flow in a tube
7. Boundary layer flow over a flat plate
8. Pressure distribution around a circular cylinder in high Reynolds number flow
9. Measurements using Forced Vortex Apparatus and Free Vortex Apparatus
10. Measure the losses in piping System
11. Measure Friction loss along a pipe
12. Pulsating flow setup
13. Flow Measuring Apparatus, (H10 Setup)
14. Flow through an Orifice (H4 Setup)
15. Water Flow Channel (H17 Setup)

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ENGINEERING & TECHNOLOGY PG (M.TECH.) COURSES
PROPOSED COURSE STRUCTURE

Course Code	COMPUTATIONALFLUIDDYNAMICS LABORATORY	L	T	P	C
21D88205		0	0	4	2
	Semester	I			

Course Objectives: Student will be able to

- Develop finite difference and finite volume discredited forms of the CFD equations.
- Formulate explicit & implicit algorithms for solving the Euler Eqns & Navier Stokes Eqns

Course Outcomes:- Student will be able to

- At the end of the course student will able to formulate explicit &implicit algorithm for solving the Euler Eqns & Navier Stokes Eqns.

List of Experiments :-

1. Simulation of Plane Poiseuille flow through long Parallel and Stationary Plates and Plotting Velocity Contours and Velocity Variation along the horizontal central line .Take the distance between the plates as 4 cm. Properties of fluid are v=0.000217m^2/sp=800kg/m^2
2. Simulation of Couette flow when the upper plates is moving with a velocity of 40m/s. Take the distance between the plates as 4 cm properties of fluid are v=0.000217m^2/s, p=800 kg/m^3 . Make simulations for a pressure gradient of 0-30000 N/m^2/mand20000Nm^2/mandreportthevariationofvelocitycontoursforeachcase.
3. Simulation of a channel flow (Tube flow) for a tube of diameter. 5 cm and take the fluid as water at 30^{0}C at the entry of the tube of length 0.7m. A heat flux of 3000W/$m^2$is imposed along a wall. Obtain the contours of velocity and temperature along the length of the tube and also obtain the centre line temperature and velocity of fluid.
4. Simulation of a channel flow (Tube flow) for a tube of diameter 5 cm and take thefluidaswaterat30^{0}Cat the entry of the tube length 0.7m .A Constant wall temperature of 300^{0}C is imposed along the wall. Obtain the contours of Velocity and temperature along the length of the tube and also obtain the centre line temperature and velocity of fluid.
5. Unsteadysimulationofcompressibleflowofairthrough2Daconvergent–Divergent nozzle, with inlet and outlet of 0.2m size and both are joined by a throat section where the flow area is reduced by 10% and is of sinusoidal shape. Air enters the nozzle at a pressure of 0.9 bar and leaves at 0.73 bar. Obtain the contours o fvelocity, pressure and Mach number.
6. Simulationofflowoveracircularcylinderofsize5cmfordifferent Reynold'snumbervalueso fairandplottingthe contours of velocity and vorticity
7. Simulation of temperature counters for a square plate of size 0.2msubjected to different types of boundary conditions.
8. Simulation of temperature counters for a pin fin in natural and forced convective conditions

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ENGINEERING & TECHNOLOGY PG (M.TECH.) COURSES
PROPOSED COURSE STRUCTURE

Course Code	OPTIMIZATION TECHNIQUES & ITS APPLICATIONS	L	T	P	C
21D88301a	Program Elective Course - V	3	0	0	3
	Semester	III			

Course Objectives: Student will be able

- To introduce the fundamental concepts of Optimization Techniques;
- To provide the concepts of various classical and modern methods of for constrained and unconstrained problems in both single and multivariable.
- To make the learners aware of the importance of optimizations in real sceneries

Course Outcomes:-

- Formulate optimization problems
- Understand and apply the concept of optimality criteria for various type of optimization problems;
- Solve various constrained and unconstrained problems in single variable as well as multivariable;

UNIT – I		Lecture Hrs:9

Introduction: Engineering Applications of optimization- statement of an optimization problem – Classification of optimization problems.
Single Variable Non-Linear Unconstrained Optimization: One dimensional Optimization methods:- Uni-modal function, elimination methods, Fibonacci method, golden section method, interpolation methods – quadratic and cubic interpolation methods.

UNIT – II		Lecture Hrs:9

Multi variable non-linear unconstrained optimization: Direct search method – Univariant method - pattern search methods – Powell's- Hook -Jeeves, Rosenbrock search methods- gradient methods, gradient of function, steepest decent method, Fletcher Reeves method, variable metric method.

Linear Programming – Graphical method-Simplex method- Dual simplex method-Revised simplex method- Parametric linear programming- Goal Programming Simulation- types of simulations- Applications of simulations to inventory, queuing and thermal systems

UNIT – III		Lecture Hrs:9

Integer Programming- Introduction – formulation – Geometry cutting plane algorithm – Zero or one algorithm, branch and bound method
Stochastic Programming: Basic concepts of probability theory, random variables- distributions-mean, variance, correlation, co variance, joint probability distribution- stochastic linear, dynamic programming.

UNIT – IV		Lecture Hrs:9

Geometric Programming: Polynomials – arithmetic - geometric inequality – unconstrained G.P- constrained G.P

UNIT – V		Lecture Hrs:9

Non Traditional Optimization Algorithms: Genetics Algorithm-Working Principles, Similarities and Differences between Genetic Algorithm and Traditional Methods. Simulated Annealing- Working Principle-Simple Problems. Application in production problems.

Textbooks:

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ENGINEERING & TECHNOLOGY PG (M.TECH.) COURSES
PROPOSED COURSE STRUCTURE

1. Optimization theory and Applications,S.S.Rao,New Age International.
2. Optimization for Engineering Design, Kalyanmoy Deb, PHI

Reference Books:

1. Operations Research, S.D.Sharma,
2. Operation Research, H.A.Taha ,TMH
3. Optimization in operations research, R.LRardin
4. Optimization Techniques, Belagundu & Chandraputla, Pearson Asia.
5. Optimization Techniques theory and practice, M.C.Joshi, K.M.Moudgalya, Narosa Publications

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ENGINEERING & TECHNOLOGY PG (M.TECH.) COURSES
PROPOSED COURSE STRUCTURE

Course Code	JET PROPULSION & ROCKETRY	L	T	P	C
21D88301b	Program Elective Course - V	3	0	0	3
	Semester	III			

Course Objectives: Student will be able to

- Analyze thermodynamics of an aircraft jet engine and calculate the performance measures, such as thrust and specific fuel consumption in terms of design requirement.
- Be able to estimate the best possible engine performance as a function of principal design parameters, such as maximum engine temperature, pressure ratio, and flight speed
- Analyze the internal mechanisms of gas turbine engine components and understand the factors that limit the practical performance of inlets, combustion chambers, and nozzles

Course Outcomes:- Student will be able to

- Understand the operating characteristics of compressors and turbines in terms of given blade shapes, angles, and direction of rotation
- Design a gas turbine engine using the understanding of the relationship between components, at least at the level of selecting the number of spools and stages
- Understand the broader context of aircraft propulsion technology, including the environmental and economic issues

UNIT – I		Lecture Hrs:9

Turbo Jet Propulsion System: Gas turbine cycle analysis – layout of turbo jet engine. Turbo machinery-compressors and turbines, combustor, blade aerodynamics, engine off design performance analysis.

Flight Performance: Forces acting on vehicle – Basic relations of motion – multi stage vehicles.
Principles of Jet Propulsion and Rocketry: Fundamentals of jet propulsion, Rockets and air breathing jet engines – Classification – turbo jet, turbo fan, turbo propulsion, rocket (Solid and Liquid propellant rockets) and Ramjet engines.

UNIT – II		Lecture Hrs:9

Nozzle: Theory and Characteristics and Parameters**:** Theory of one dimensional convergent – divergent nozzles – aerodynamic choking of nozzles and mass flow through a nozzle – nozzle exhaust velocity – thrust, thrust coefficient, Ac / At of a nozzle, Supersonic nozzle shape, non-adapted nozzles, summer field criteria, departure from simple analysis – characteristic parameters

1) characteristic velocity, 2) specific impulse 3) total impulse 4) relationship between the characteristic parameters 5) nozzle efficiency, combustion efficiency and overall efficiency.

UNIT – III		Lecture Hrs:9

Aero Thermo Chemistry of The Combustion Products: Review of properties of mixture of gases – Gibbs – Dalton laws – Equivalent ratio, enthalpy changes in reactions, heat of reaction and heat of formation – calculation of adiabatic flame temperature and specific impulse – frozen and equilibrium flows.

Solid Propulsion System: Solid propellants – classification, homogeneous and heterogeneous propellants, double base propellant compositions and manufacturing methods. Composite propellant oxidizers and binders. Effect of binder on propellant properties. Burning rate and burning rate laws, factors influencing the burning rate, methods of determining burning rates

UNIT – IV		Lecture Hrs:9

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ENGINEERING & TECHNOLOGY PG (M.TECH.) COURSES
PROPOSED COURSE STRUCTURE

Solid propellant rocket engine – internal ballistics, equilibrium motor operation and equilibrium pressure to various parameters. Transient and pseudo equilibrium operation, end burning and burning grains, grain design. Rocket motor hard ware design. Heat
transfer considerations in solid rocket motor design. Ignition system, simple pyro devices.
Liquid Rocket Propulsion System: Liquid propellants – classification, Mono and Bi propellants, Cryogenic and storage propellants, ignition delay of hypergolic propellants, physical and chemical characteristics of liquid propellant. Liquid propellant rocket engine – system layout, pump and pressure feed systems, feed system components. Design of combustion chamber, characteristic length, constructional features, and chamber wall stresses. Heat transfer and cooling aspects. Uncooled engines, injectors – various types, injection patterns, injector characteristics, and atomization and drop size distribution, propellant tank design.

UNIT – V		Lecture Hrs:9

Ramjet and Integral Rocket Ramjet Propulsion System: Fuel rich solid propellants, gross thrust, gross thrust coefficient, combustion efficiency of ramjet engine, air intakes and their classification – critical, super critical and sub-critical operation of air intakes, engine intake matching, classification and comparison of IIRR propulsion systems.

Textbooks:

1. Mechanics and Dynamics of Propulsion, Hill and Peterson
2. Rocket propulsion elements, Sutton

Reference Books:

1. Gas Turbines, Ganesan (TMH)
2. Gas Turbines and Propulsive Systems, Khajuria & Dubey (Dhanpatrai)
3. Rocket propulsion, Bevere
4. Jet propulsion, Nicholas Cumpsty

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ENGINEERING & TECHNOLOGY PG (M.TECH.) COURSES
PROPOSED COURSE STRUCTURE

Course Code	AIR CRAFT AND SPACE PROPULSION	L	T	P	C
21D88301c	Program Elective Course - V	3	0	0	3
	Semester	III			

Course Objectives: Student will be able to

- Gain insight on the working principle of rocket engines, different feed systems, propellants and their properties and dynamics of rockets.

Course Outcomes:- Student will be able to

Understand the working of different types of aircraft and rocket propulsion systems and their performance characteristics.

UNIT – I — Lecture Hrs:9

GAS DYNAMICS

Wave motion - Compressible fluid flow through variable area devices – Stagnation state Mach Number and its influence and properties, Isentropic Flow, Rayleigh and Fanno Flow. Deflagration and Detonation – Normal shock and oblique shock waves.

UNIT – II — Lecture Hrs:9

THERMODYNAMICS OF AIRCRAFT ENGINES

Theory of Aircraft propulsion – Thrust – Various efficiencies – Different propulsion systems – Turboprop – Ram Jet – Turbojet, Turbojet with after burner, Turbo fan and Turbo shaft. Variable thrust-nozzles – vector control.

UNIT – III — Lecture Hrs:9

PERFORMANCE CHARACTERISTICS OF AIRCRAFT ENGINES

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

UNIT – IV — Lecture Hrs:9

ROCKET PROPULSION

Theory of rocket propulsion – Rocket equations – Escape and Orbital velocity – Multi-staging of Rockets – Space missions – Performance characteristics – Losses and efficiencies

UNIT – V — Lecture Hrs:9

ROCKET THRUST CHAMBER

Combustion in solid and liquid propellant classification – rockets of propellants and Propellant Injection systems – Non-equilibrium expansion and supersonic combustion – Propellant feed systems – Reaction Control Systems - Rocket heat transfer.

Textbooks:

1. Philip G. Hill and Carl R. Peterson, Mechanics and Thermodynamics of Propulsion, Second
2. Edition, Addition – Wesley Publishing Company, New York, 2009.
3. Zucrow N.J. Principles of Jet Propulsion and Gas Turbines, John Wiley and Sons New York, 1970

Reference Books:

1. Zucrow N.J. Aircraft and Missile Propulsion, Vol. I and Vol. II, John Wiley and Sons Inc, New York, 1975.
2. S. M.Yahya, Fundamentals of Compressible Flow. Third edition, New Age International Pvt Ltd, 2003.
3. Bonney E.A. Zucrow N.J. Principles of Guided Missile Design, Van Nostranc Co., 1956.

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AUDIT COURSE-I

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ENGINEERING & TECHNOLOGY PG (M.TECH.) COURSES
PROPOSED COURSE STRUCTURE

Course Code	ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C
21DAC101a		2	0	0	0
	Semester	I			

Course Objectives: This course will enable students:

- Understand the essentials of writing skills and their level of readability
- Learn about what to write in each section
- Ensure qualitative presentation with linguistic accuracy

Course Outcomes (CO): Student will be able to

- Understand the significance of writing skills and the level of readability
- Analyze and write title, abstract, different sections in research paper
- Develop the skills needed while writing a research paper

UNIT - I		Lecture Hrs:10
1Overview of a Research Paper- Planning and Preparation- Word Order- Useful Phrases - Breaking up Long Sentences-Structuring Paragraphs and Sentences-Being Concise and Removing Redundancy -Avoiding Ambiguity		
UNIT - II		Lecture Hrs:10
Essential Components of a Research Paper- Abstracts- Building Hypothesis-Research Problem - Highlight Findings- Hedging and Criticizing, Paraphrasing and Plagiarism, Cauterization		
UNIT - III		Lecture Hrs:10
Introducing Review of the Literature – Methodology - Analysis of the Data-Findings - Discussion-Conclusions-Recommendations.		
UNIT - IV		Lecture Hrs:9
Key skills needed for writing a Title, Abstract, and Introduction		
UNIT - V		Lecture Hrs:9
Appropriate language to formulate Methodology, incorporate Results, put forth Arguments and draw Conclusions		

Suggested Reading

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books) Model Curriculum of Engineering & Technology PG Courses [Volume-I]
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

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ENGINEERING & TECHNOLOGY PG (M.TECH.) COURSES
PROPOSED COURSE STRUCTURE

Course Code	DISASTER MANAGEMENT	L	T	P	C
21DAC101b		2	0	0	0
	Semester	I			

Course Objectives: This course will enable students:

- Learn to demonstrate critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Critically evaluatedisasterriskreduction and humanitarian response policy and practice from
- Multiple perspectives.
- Developanunderstandingofstandardsofhumanitarianresponseandpracticalrelevanceinspecific types of disasters and conflict situations
- Criticallyunderstandthestrengthsandweaknessesofdisastermanagementapproaches,planningand programming in different countries, particularly their home country or the countries they work in

UNIT - I

Introduction:
Disaster:Definition,FactorsandSignificance;DifferenceBetweenHazardandDisaster;Naturaland Manmade Disasters: Difference, Nature, Types and Magnitude.
Disaster Prone Areas in India:
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 - II

Repercussions of Disasters and Hazards:
Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes,Volcanisms,Cyclones,Tsunamis,Floods,DroughtsandFamines,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 Preparedness and Management:
Preparedness: Monitoring of Phenomena Triggering ADisasteror Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT - IV

Risk Assessment Disaster Risk:
Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. TechniquesofRiskAssessment,GlobalCo-OperationinRiskAssessmentand Warning, People's Participation in Risk Assessment. Strategies for Survival.

UNIT - V

Disaster Mitigation:
Meaning,ConceptandStrategiesofDisasterMitigation,EmergingTrendsInMitigation.Structural Mitigationand Non-Structural Mitigation, Programs of Disaster Mitigation in India.

Suggested Reading

1. R.Nishith,SinghAK,"DisasterManagementinIndia:Perspectives,issuesandstrategies
2. "'New Royal book Company..Sahni,PardeepEt.Al.(Eds.),"DisasterMitigationExperiencesAndReflections",PrenticeHa ll OfIndia, New Delhi.
3. GoelS.L.,DisasterAdministrationAndManagementTextAndCaseStudies",Deep&Deep Publication Pvt. Ltd., New Delhi

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ENGINEERING & TECHNOLOGY PG (M.TECH.) COURSES
PROPOSED COURSE STRUCTURE

Course Code	SANSKRITFOR TECHNICAL KNOWLEDGE	L	T	P	C
21DAC101c		2	0	0	0
	Semester	I			

Course Objectives: This course will enable students:

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- Learning of Sanskrit to improve brain functioning
- LearningofSanskrittodevelopthelogicinmathematics,science&othersubjects enhancing the memory power
- The engineering scholars equipped with Sanskrit will be able to explore the huge
- Knowledge from ancientliterature

Course Outcomes (CO): Student will be able to

- Understanding basic Sanskrit language
- Ancient Sanskrit literature about science &technology can be understood
- Being a logical language will help to develop logic in students

UNIT - I		
Alphabets in Sanskrit,		
UNIT - II		
Past/Present/Future Tense, Simple Sentences		
UNIT - III		
Order, Introduction of roots		
UNIT - IV		
Technical information about Sanskrit Literature		
UNIT - V		
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics		

Suggested Reading

1.“Abhyaspustakam” –Dr.Vishwas, Sanskrit-Bharti Publication, New Delhi
2.“Teach Yourself Sanskrit” Prathama Deeksha- VempatiKutumbshastri, RashtriyaSanskrit Sansthanam, New Delhi Publication
3.“India’s Glorious ScientificTradition” Suresh Soni, Ocean books (P) Ltd.,New Delhi

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ENGINEERING & TECHNOLOGY PG (M.TECH.) COURSES
PROPOSED COURSE STRUCTURE

AUDIT COURSE-II

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ENGINEERING & TECHNOLOGY PG (M.TECH.) COURSES
PROPOSED COURSE STRUCTURE

Course Code	PEDAGOGY STUDIES	L	T	P	C
21DAC201a		2	0	0	0
	Semester	II			

Course Objectives: This course will enable students:

- Reviewexistingevidenceonthereviewtopictoinformprogrammedesignandpolicy making undertaken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

Course Outcomes (CO): Student will be able to

- Students will be able to understand:
- Whatpedagogicalpracticesarebeingusedbyteachersinformalandinformalclassrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what
- conditions, and with what population of learners?
- Howcanteachereducation(curriculumandpracticum)andtheschoolcurriculumand guidance materials best support effective pedagogy?

UNIT - I

Introduction and Methodology: Aims and rationale, Policy back ground, Conceptual frame work and terminology Theories oflearning,Curriculum,Teachereducation.Conceptualframework,Research questions. Overview of methodology and Searching.

UNIT - II

Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.

UNIT - III

Evidence on theeffectivenessofpedagogicalpractices,Methodologyfortheindepthstage:quality assessmen t of included studies. How can teacher education (curriculumandpracticum) andthescho curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of th body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT - IV

Professional development: alignment with classroom practices and follow-up support, Peer support, Support from the head
teacherandthecommunity.Curriculumandassessment,Barrierstolearning:limitedresourcesand large class sizes

UNIT - V

Researchgapsandfuturedirections:Researchdesign,Contexts,Pedagogy,Teachereducation, Curriculum and assessment, Dissemination and research impact.

Suggested Reading

1. AckersJ,HardmanF(2001)ClassroominteractioninKenyanprimaryschools,Compare, 31 (2): 245-261.
2. AgrawalM(2004)Curricularreforminschools:Theimportanceofevaluation,Journalof
3. Curriculum Studies, 36 (3): 361-379.
4. AkyeampongK(2003) Teacher training in Ghana - does it count? Multi-site teachereducation research project (MUSTER) country report 1. London: DFID.
5. Akyeampong K, LussierK, PryorJ, Westbrook J (2013)Improving teaching and learning of basic maths and reading in Africa: Does teacherpreparation count?International Journal Educational Development, 33 (3): 272–282.
6. Alexander RJ(2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
   Chavan M (2003)ReadIndia: A mass scale, rapid, 'learning to read'campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

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ENGINEERING & TECHNOLOGY PG (M.TECH.) COURSES
PROPOSED COURSE STRUCTURE

Course Code	STRESSMANAGEMENT BY YOGA	L	T	P	C
21DAC201b		2	0	0	0
	Semester	**II**			
Course Objectives: This course will enable students:					
• To achieve overall health of body and mind • To overcome stres					
Course Outcomes (CO): Student will be able to					
• Develop healthy mind in a healthy body thus improving social health also • Improve efficiency					
UNIT - I					
Definitions of Eight parts of yog.(Ashtanga)					
UNIT - II					
Yam and Niyam.					
UNIT - III					
Do`sand Don't'sin life. i) Ahinsa,satya,astheya,bramhacharyaand aparigrahaii) Shaucha,santosh,tapa,swadhyay,ishwarpranidhan					
UNIT - IV					
Asan and Pranayam					
UNIT - V					
i)Variousyogposesand theirbenefitsformind &body ii)Regularizationofbreathingtechniques and its effects-Types ofpranayam					
Suggested Reading					
1.'Yogic Asanas forGroupTarining-Part-I": Janardan SwamiYogabhyasiMandal, Nagpur 2."Rajayogaor conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata					

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ENGINEERING & TECHNOLOGY PG (M.TECH.) COURSES
PROPOSED COURSE STRUCTURE

Course Code	PERSONALITY DEVELOPMENT THROUGHLIFE	L	T	P	C
21DAC201c	ENLIGHTENMENTSKILLS	2	0	0	0
	Semester	**II**			

Course Objectives: This course will enable students:

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

Course Outcomes (CO): Student will be able to

- StudyofShrimad-Bhagwad-Geetawillhelpthestudentindevelopinghispersonalityand achieve the highest goal in life
- The person who has studied Geetawilllead the nation and mankind to peace and prosperity
- Study of Neetishatakam will help in developing versatile personality of students

UNIT - I

Neetisatakam- Holistic development of personality
Verses-19,20,21,22(wisdom)
Verses-29,31,32(pride &heroism)
Verses-26,28,63,65(virtue)

UNIT - II

Neetisatakam- Holistic development of personality
Verses-52,53,59(dont's)
Verses-71,73,75,78(do's)

UNIT - III

Approach to day to day work and duties.
ShrimadBhagwadGeeta:Chapter2-Verses41,47,48,
Chapter3-Verses13,21,27,35,Chapter6-Verses5,13,17,23,35,
Chapter18-Verses45,46,48.

UNIT - IV

Statements of basic knowledge.
ShrimadBhagwadGeeta:Chapter2-Verses 56,62,68
Chapter12 -Verses13,14,15,16,17,18
Personality of Rolemodel. Shrimad Bhagwad Geeta:

UNIT - V

Chapter2-Verses 17,Chapter3-Verses36,37,42,
Chapter4-Verses18,38,39
Chapter18– Verses37,38,63

Suggested Reading

1."SrimadBhagavadGita"bySwamiSwarupanandaAdvaitaAshram(PublicationDepartment), Kolkata
2.Bhartrihari'sThree Satakam (Niti-sringar-vairagya) by P.Gopinath, RashtriyaSanskrit Sansthanam, New Delhi.

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ENGINEERING & TECHNOLOGY PG (M.TECH.) COURSES
PROPOSED COURSE STRUCTURE

Course Code	BUSINESS ANALYTICS	L	T	P	C
21DOE301c		3	0	0	3
	Semester	III			

Course Objectives:

- The main objective of this course is to give the student a comprehensive understanding of
- business analytics methods.

Course Outcomes (CO): Student will be able to

- Students will demonstrate knowledge of data analytics.
- Students will demonstrate the ability of think critically in making decisions based on
- data and deep analytics.
- Students will demonstrate the ability to use technical skills in predicative and
- prescriptive modeling to support business decision-making.
- Students will demonstrate the ability to translate data into clear, actionable insights.

UNIT - I — Lecture Hrs:

Business Analysis: Overview of Business Analysis, Overview of Requirements, Role of the Business Analyst.
Stakeholders: the project team, management, and the front line, Handling Stakeholder Conflicts.

UNIT - II — Lecture Hrs:

Life Cycles: Systems Development Life Cycles, Project Life Cycles, Product Life Cycles, Requirement Life Cycles.

UNIT - III — Lecture Hrs:

Forming Requirements: Overview of Requirements, Attributes of Good Requirements, Types of Requirements, Requirement Sources, Gathering Requirements from Stakeholders, Common Requirements Documents.Transforming Requirements: Stakeholder Needs Analysis, Decomposition Analysis, Additive/Subtractive Analysis, Gap Analysis, Notations (UML & BPMN), Flowcharts, Swim Lane Flowcharts, Entity-Relationship Diagrams, State-Transition Diagrams, Data Flow Diagrams, Use Case Modeling, Business Process Modeling

UNIT - IV — Lecture Hrs:

Finalizing Requirements: Presenting Requirements, Socializing Requirements and Gaining Acceptance, Prioritizing Requirements. Managing Requirements Assets: Change Control, Requirements Tools

UNIT - V — Lecture Hrs:

Recent Trands in: Embedded and colleborative business intelligence, Visual data recovery, Data Storytelling and Data Journalism.

Textbooks:

1. Business Analysis by James Cadle et al.
2. Project Management: The Managerial Process by Erik Larson and, Clifford Gray

Reference Books:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

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ENGINEERING & TECHNOLOGY PG (M.TECH.) COURSES
PROPOSED COURSE STRUCTURE

Course Code	INTERNET OF THINGS (IOT)	L	T	P	C
21DOE301g		3	-	-	3
	Semester	III			

Course Objectives: Student will be able

- To study fundamental concepts of IoT
- To understand roles of sensors in IoT
- To Learn different protocols used for IoT design
- To be familiar with data handling and analytics tools in IoT
- Appreciate the role of big data, cloud computing and data analytics in a typical IoT system

Course Outcomes (CO): Student will be able to

- Understand the various concepts, terminologies and architecture of IoT systems.
- Use sensors and actuators for design of IoT.
- Understand and apply various protocols for design of IoT systems
- Use various techniques of data storage and analytics in IoT
- Understand various applications of IoT
- Understand APIs to connect IoT related technologies

UNIT – I	Lecture Hrs:09

Fundamentals of IoT: Introduction, Definitions & Characteristics of IoT, IoT Architectures, Physical & Logical Design of IoT, Enabling Technologies in IoT, History of IoT, About Things in IoT, The Identifiers in IoT, About the Internet in IoT, IoT frameworks, IoT and M2M

UNIT – II	Lecture Hrs: 09

Sensors Networks : Definition, Types of Sensors, Types of Actuators, Examples and Working, IoT Development Boards: Arduino IDE and Board Types, RaspberriPi Development Kit, RFID Principles and components, Wireless Sensor Networks: History and Context, The node, Connecting nodes, Networking Nodes, WSN and IoT.

UNIT – III	Lecture Hrs: 09

Wireless Technologies for IoT: WPAN Technologies for IoT: IEEE 802.15.4, Zigbee, HART, NFC, Z-Wave, BLE, Bacnet, Modbus.
IP Based Protocols for IoT IPv6, 6LowPAN, RPL, REST, AMPQ, CoAP, MQTT. Edge connectivity and protocols

UNIT – IV	Lecture Hrs: 09

Data Handling& Analytics: Introduction, Bigdata, Types of data, Characteristics of Big data, Data handling Technologies, Flow of data, Data acquisition, Data Storage, Introduction to Hadoop. Introduction to data Analytics, Types of Data analytics, Local Analytics, Cloud analytics and applications

UNIT - V	Lecture Hrs: 09

Applications of IoT: Home Automation, Smart Cities, Energy, Retail Management, Logistics, Agriculture, Health and Lifestyle, Industrial IoT, Legal challenges, IoT design Ethics, IoT in Environmental Protection.

Textbooks:

1.Hakima Chaouchi, — "The Internet of Things Connecting Objects to the Web" ISBN : 978-1-84821-140-7, Wiley Publications
2.Olivier Hersent, David Boswarthick, and Omar Elloumi, — "The Internet of Things: Key Applications and Protocols", WileyPublications
3.Vijay Madisetti and ArshdeepBahga, — "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014.
4.J. Biron and J. Follett, "Foundational Elements of an IoT Solution", O'Reilly Media, 2016.
5.Keysight Technologies, "The Internet of Things: Enabling Technologies and Solutions for Design and Test", Application Note, 2016.

Reference Books:

1.Daniel Minoli, — "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of

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M2M Communications", ISBN: 978-1-118-47347-4, Willy Publication 2.Pethuru Raj and Anupama C. Raman, "The Internet of Things: EnablingTechnologies, Platforms, and Use Cases", CRC Press
Online Learning Resources:
https://onlinecourses.nptel.ac.in/noc17_cs22/course http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html

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PROPOSED COURSE STRUCTURE

Course Code	MECHATRONICS	L	T	P	C
21DOE301h		3	0	0	3
	Semester	III			

Course Objectives: Student will be able

- To study fundamental concepts of Signal condition
- To understand the concepts of precision mechanical systems
- To Learn different electronic interface subsystems
- To be familiar with microcontrollers overview.
- To understand the concepts of programmable logic controllers

Course Outcomes (CO): Student will be able to

- Understand the various concepts, terminologies of Signal condition
- Understand the basics electronic interface subsystems
- Understand and apply various precision mechanical systems
- Understand various applications of microcontrollers overview
- Understand the controlling of programmable logic and programmable motion.

UNIT – I		Lecture Hrs:09

INTRODUCTION : Definition – Trends - Control Methods: Standalone , PC Based (Real Time Operating Systems, Graphical User Interface , Simulation) - Applications: SPM, Robot, CNC, FMS, CIM.

SIGNAL CONDITIONING : Introduction – Hardware - Digital I/O, Analog input – ADC, resolution , speed channels Filtering Noise using passive components – Resistors, capacitors - Amplifying signals using OP amps – Software - Digital Signal Processing – Low pass , high pass , notch filtering.

UNIT – II		Lecture Hrs: 09

PRECISION MECHANICAL SYSTEMS : Pneumatic Actuation Systems - Electro-pneumatic Actuation Systems - Hydraulic Actuation Systems - Electro-hydraulic Actuation Systems - Timing Belts – Ball Screw and Nut - Linear Motion Guides - Linear Bearings - Harmonic Transmission - Bearings- Motor / Drive Selection.

UNIT – III		Lecture Hrs: 09

ELECTRONIC INTERFACE SUBSYSTEMS : TTL, CMOS interfacing - Sensor interfacing – Actuator interfacing – solenoids , motors Isoation schemes- opto coupling, buffer IC's - Protection schemes – circuit breakers , over current sensing , resetable fuses , thermal dissipation - Power Supply - Bipolar transistors / mosfets

ELECTROMECHANICAL DRIVES : Relays and Solenoids - Stepper Motors - DC brushed motors – DC brushless motors - DC servo motors - 4-quadrant servo drives , PWM's - Pulse Width Modulation – Variable Frequency Drives, Vector Drives - Drive System load calculation

UNIT – IV		Lecture Hrs: 09

MICROCONTROLLERS OVERVIEW: 8051 Microcontroller , micro processor structure - DigitalInterfacing - Analog Interfacing - Digital to Analog Convertors - Analog to Digital Convertors - Applications. Programming –Assembly , C (LED Blinking , Voltage measurement using ADC).

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UNIT - V		Lecture Hrs: 09
PROGRAMMABLE LOGIC CONTROLLERS : Basic Structure - Programming : Ladder diagram -Timers, Internal Relays and Counters - Shift Registers - Master and Jump Controls - Data Handling - Analog input / output - PLC Selection - Application. **PROGRAMMABLE MOTION CONTROLLERS** : Introduction - System Transfer Function – Laplace transform and its application in analysing differential equation of a control system - Feedback Devices :Position , Velocity Sensors - Optical Incremental encoders - Proximity Sensors : Inductive , Capacitive ,		
Textbooks:		
1. A text book of Mechatronics by Er.R.K. RAJPUT ., S.CHAND publications 2. A text book of Mechatronics by Nitalgour Premchand Mahalik ., McGraw Hill publications		
Reference Books:		
1. A text book of Mechatronics by W.Bolton ., Pearson Publications		