SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY::PUTTUR

(AUTONOMOUS)

DEPARTMENT OF MECHANICAL ENGINEERING

MASTER OF TECHNOLOGY

THERMAL ENGINEERING (ME)

COURSE STRUCTURE (I& II YEAR)

I YEAR I SEMESTER

S NO.	COURSE CODE	SUBJECT	L	T	P	C
1.	19HS0823	Research Methodology and IPR	2	-	-	2
2.	19ME3101	Thermodynamics and Combustion	3	-	-	3
3.	19ME3102	Advanced Fluid Dynamics	3	-	-	3
Programme Elective-I						
4.	19ME3112	Nuclear Engineering	3	-	-	3
	19ME3113	Energy Conservation and Management				
	19ME3122	Energy Management in Thermal Systems				
Programme Elective-II						
5.	19ME3114	Air Conditioning System Design	3	-	-	3
	19ME3115	Jet Propulsion and Rocketry				
	19ME3123	Fuels and Combustion				
6.	19ME3103	Thermal Engineering Lab	-	-	4	2
7.	19ME3104	Computer Aided Analysis Lab	-	-	4	2
Audit Course-I						
8.	19HS0818	English for Research Paper writing	2	-	-	-
Contact Periods / Week			**16**	**-**	**8**	**18**
			Total/Week 24			

I YEAR II SEMESTER

S NO.	COURSE CODE	SUBJECT	L	T	P	C
1.	19ME3105	Advanced Heat Transfer	3	-	-	3
2.	19ME3106	Steam Engineering	3	-	-	3
Programme Elective-III						
3.	19ME3116	Refrigeration and Cryogenics	3	-	-	3
	19ME3117	Design of Heat Exchangers				
	19ME3124	Cryogenic Engineering				
Programme Elective-IV						
4.	19ME3118	Computational Fluid Dynamics	3	-	-	3
	19ME3119	Modeling of IC Engines				
	19ME3125	Instrumentation for Thermal Engineering				
5.	19ME3107	Computational Fluid Dynamics Lab	-	-	4	2
6.	19ME3108	Thermal Engineering Lab (Virtual Lab)	-	-	4	2
Audit Course-II						
7.	19HS0829	Constitution of India	2	-	-	-
8.	19ME3109	Mini-Project	-	-	4	2
Contact Periods / Week			**14**	**-**	**12**	**18**
			Total/Week 26			

II YEAR I SEMESTER

S. No	COURSE CODE	SUBJECT	L	T	P	C
PROGRAMME ELECTIVE-V						
1.	19ME3120	Design of Solar and Wind System	3	-	-	3
	19ME3126	Finite Element Methods in Thermal Engineering				
	19ME3127	Thermal Measurements and Process Control				
OPEN ELECTIVE						
2.	19HS0824	Business Analytics	3	-	-	3
	19CE1028	Cost Management of Engineering Projects				
	19EE2128	Waste to Energy				
	19ME3121	Industrial Safety				
	19ME3021	Advances in Operations Research				
	19ME3022	Composite Materials				
3.	19ME3110	Dissertation Phase – I	-	-	20	10
		Contact periods/week	**6**	**-**	**20**	**16**
			Total/Week 26			

II YEAR II SEMESTER

S No.	COURSECODE	SUBJECT	L	T	P	C
1.	19ME3111	Dissertation Phase – II	-	-	32	16
		Contact periods/week	-	-	**32**	**16**
			Total/Week 32			

Total Number of Credits= 18 +18+16+16 = 68

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I M.Tech – I Sem

L	T	P	C
2	-	-	2

(19HS0823) RESEARCH METHODOLOGY AND IPR

COURSE OBJECTIVES

At the end of this course, students will be able to:

1. Understand some basic concepts of research and its methodologies
2. Identify appropriate research topics
3. Enrich knowledge to their research field
4. Process for filing Patent

COURSE OUTCOMES

1. Recognize appropriate research problem, errors in selecting a research problem, Scope and objectives of research
2. Critically assess research methods pertinent to technology innovation research
3. *Identify, explain, compare, and prepare the key elements of a research proposal/report*
4. Skill to understand the need of intellectual property rights, IPR protection to inventors
5. Develop procedural knowledge to Legal System and solving the problem relating to intellectual property rights for further research work and investment in R & D

UNIT – I

Research: 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

Literature Survey in Research: Effective literature studies approaches - analysis - Plagiarism - Research ethics

UNIT – III

Project Report: 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 – IV

Intellectual Property Rights: Nature of Intellectual Property – Patents, Designs, Trade and Copyrights - 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 – V

Patent Rights: Scope of Patent Rights - Licensing and transfer of technology –Patent information and databases - Geographical Indications - New Developments in IPR - Administration of Patent System - New developments in IPR - IPR of Biological Systems, Computer Software - Traditional knowledge, Case Studies - IPR and IITs

TEXT BOOKS

1. CR Kothari, "*Research Methodology: Methods and Techniques*" 3rd Edition, New Age International(P) Limited, Publishers, 2013
2. Neeraj Pandey & Khushdeep Dharani, "*Intellectual Property Rights*" Eastern Economy Edition, PHI Learning Private Limited.

REFERENCES

1. John W. Creswell, "Research Design – Qualitative, Quantitative and Mixed Methods Approaches" 4th Edition, SAGE Publications, New Delhi 2014
2. Ranjit Kumar, 4th Edition, "*Research Methodology: A Step by Step Guide for beginners*" SAGE Publications, New Delhi, 2014.
3. Ramakrishna B & Anil Kumar H.S "*Fundamentals of Intellectual Property Rights- for students, Industrialist and Patent Lawyers*", First Published, Notion Press, Chennai, 2017.
4. Ahuja VK, "*Intellectual Property Rights in India*", Second Edition, Mittal Books India, 2015.
5. KC Kankanala, AK Narasani & V Radhakrishnan, "*Indian Patent Law and Practice*", Oxford India Paperbacks, Edition, 2012.

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(19ME3101) THERMODYNAMICS AND COMBUSTION

COURSE OBJECTIVES

1. To understand the first and second law of thermodynamics
2. To recognize the Principles of combustion
3. To know about combustion and thermo chemistry.
4. To be aware of the Combustion Equipment used in the combustion
5. To understand the direct energy conversion

COURSE OUTCOMES

On successful Completion of this course the student will be able to
1. Understand the concepts of transient flow analysis and real gas mixture
2. Describe the concepts of Chemical composition
3. Have a broad knowledge on chemical equilibrium
4. Have a broad knowledge on the concepts of Nerst heat theorem
5 Identify the applications of the fuel cells and magneto hydro dynamic generators.

UNIT - I:
Introduction: First law and State postulates, Second law and Entropy, Availability and Irreversibility, Transient flow analysis, Enthalpy of formation–Heating value of fuel - Adiabatic flame Temperature – Equilibrium composition of gaseous mixtures.

UNIT-II
Principles of Combustion–Chemical composition–Flue gas analysis–dew point of products – Combustion stoichiometry. Combustion of fuel, droplets and sprays – Combustion systems – Pulverized fuel furnaces – fixed, Entrained and Fluidized Bed Systems.

UNIT – III:
Combustion and Thermo-Chemistry, Second law analysis of reacting mixture, Chemical equilibrium, –Flame stability– Burning velocity of fuels – Measurement of burning velocity – factors affecting the burning velocity.

UNIT - IV:
Combustion Equipment– Burners - 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.

UNIT - V:
Direct Energy Conversion- introduction – Fuel Cells – Thermo-electric energy – Thermo-ionic power generation -Thermodynamic devices Magneto Hydrodynamic Generators – Photo voltaic cell

TEXT BOOKS

1. Cengel, *Thermodynamics*, Tata McGraw Hill Co., New Delhi, 2010
2. Howell and Dedcius, *Fundamentals of Engineering Thermodynamics*, McGraw Hill Inc., U.S.A, 2009

REFERENCES

1. Van Wylen & Sonntag, *Thermodynamics*, John Wiley and Sons Inc., U.S.A, 2008
2. Holman, *Thermo dynamics*, Mc Graw Hill, 2008
3. HR De Groff, *Irreversible Thermo Dynamics*, Mc Graw Hill, 2005

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(19ME3102) ADVANCED FLUID DYNAMICS

COURSE OBJECTIVES

1. *To learn about various governing equations in Fluid Dynamics.*
2. *To know about Potential and Internal Flows.*
3. *To gain knowledge on Laminar boundary layers.*
4. *To understand about Characteristics and governing equations of turbulent flow.*
5. *To learn about data analysis of fluids and design of experiments.*

COURSE OUTCOMES

Students undergoing this course

1. *Knows about the governing equations in fluid dynamics.*
2. *Be familiar with the concepts of potential and internal flows.*
3. *Gains Knowledge on concepts of laminar boundary layers*
4. *Understands the Characteristics and governing equations of turbulent flow.*
5. *Demonstrate the data analysis of fluids and design of experiments.*

UNIT – I

Governing Equations in Fluid Dynamics: Derivation of Continuity and Momentum equations using integral and differential approach - dimensionless form and special form of governing equations - integral quantities.

Exact Solutions of Navier Stokes Equations: Fully developed flows - parallel flow in straight channel - Couette flow - Creeping flows.

UNIT – II

Potential Flow: Kelvin's theorem - Irrotational flow - Stream function - vorticity approach - Application of empirical relations to various geometries for Laminar and Turbulent flows.

Internal Flows: Use of empirical correlations - Reynolds – Colburn Analogy - Application of empirical relations to various geometries for Laminar and Turbulent flows.

UNIT – III

Laminar Boundary Layers: Boundary layer equations - Flow over flat plate - Momentum integral equation for boundary layer - approximate solution methodology for boundary layer equations.

UNIT – IV

Turbulent Flow: Characteristics of turbulent flow - laminar turbulent transition - time mean motion and fluctuations - Derivation of governing equations for turbulent flow - shear stress models - universal velocity distribution.

UNIT – V

Experimental Techniques: Role of experiments in fluid - Layout of fluid flow experiments - sources of error in experiments - data analysis - Design of experiments - Review of probes and transducers - Introduction to Hot wire Anemometry - Laser Doppler Velocimetry and Particle Image Velocimeter.

TEXT BOOKS

1. K.Muralidhar & G.Biswas, *Advanced Engineering Fluid Mechanics,* Alpha Science International Ltd., 2nd revised Edition, 2005.
2. Irving H. Shames, *Mechanics of Fluids*, McGraw Hill, 4th Edition, 2003.

REFERENCES

1. Philip J. Pritchard, *Fox and McDonald Introduction to Fluid Mechanics*, John Wiley and Sons Inc, 8th Edition, 2011.
2. Yunus A. Cengel, *Heat Transfer: A Practical approach*, McGraw Hill, 2nd Edition, 2007.
3. D.S. Kumar , *Heat and Mass Transfer*, S. K. Kataria & Sons, Reprint 2013 Edition, 2013.
4. P.K. Nag, *Heat and Mass Transfer*, McGraw Hill Education, 3rd Edition, 2011.

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(19ME3112) NUCLEAR ENGINEERING

COURSE OBJECTIVES

1. *To learn about basics of nuclear fission and power from fission.*
2. *To learn about Neutron transport and diffusion*
3. *To learn about Multi group, Multi region diffusion equation, concept of criticality.*
4. *To learn about Reactor kinetics, control and radiation protection*
5. *To learn about heat extraction from Reactor and its safety*

COURSE OUTCOMES

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

1. *Understand the power from fission and conversion and breeding.*
2. *Understand the concepts of criticality of thermal reactors.*
3. *Understand the concepts of solutions for simple cases of reactivity additions*
4. *Understand the Reactor safety philosophy and radiation protection standards*
5. *Understand the hear extraction method from reactor and safety precaution*

UNIT – I

Basics of Nuclear Fission and Power From Fission: Radioactivity - nuclear reactions - cross sections - nuclear fission - power from fission -, conversion and breeding - fertile material

UNIT- II

Neutron Transport and Diffusion: Neutron transport equation - diffusion theory approximation - Fick's law - solutions to diffusion equation for point source - planar source, etc., - energy loss in elastic collisions - neutron slowing down.

UNIT – III

Multi Group, Multi Region Diffusion Equation, Concept of Criticality: Solution of multi group diffusion equations in one region and multi region reactors - concept of criticality of thermal reactors.

Types of Reactors: Pressurized Water Reactor - Boiling Water Reactor, Sodium, Graphite Reactor, Fast breeder Reactor, Homogeneous Reactor, Gas Cooled Reactor.

UNIT- IV

Reactor Kinetics and Control: Derivation of point kinetics equations in hour equation- solutions for simple cases of reactivity additions- fission product poison, reactivity coefficients- Radiation Hazards and Shielding -Radioactive Waste Disposal.

UNIT – V

Heat Removal From Reactor Core: Solution of heat transfer equation in reactor core, temperature distribution, and critical heat flux.

Reactor Safety, Radiation Protection: Reactor safety philosophy - defense in depth - units of radioactivity exposure - radiation protection standards.

TEXT BOOKS

1. John R. Lamarsh, Anthony J. Barrata, *Introduction to Nuclear Engineering* Prentice Hall, 4th Edition, 2001.
2. John. R Lamarsh & Anthony J. Baratta, *Introduction to Nuclear Engineering,* Pearson Education Incorporated, 3rd Edition 2017.

REFERENCES

1. J. Kenneth Shultis, Richard E. Faw., *Fundamentals of Nuclear Science and Engineering,* CRC Press, 2016.
2. Brent J. Lewis, E. Nihan Onder, Andrew A. Prudil, *Fundamentals of Nuclear Engineering,* John Wiley & Sons, 2017.
3. Dr.G.Vaidyanathan, *Nuclear Reactor Engineering (Principles and Concepts*), Repro Knowledge cast Limited, 3rd Edition, 2017.
4. D. C. Tayal, *Nuclear Physics* , Himalaya Publishing House, 2nd Edition, 2009.

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(19ME3113) ENERGY CONSERVATION AND MANAGEMENT

COURSE OBJECTIVES

1. *To learn about Principles of Energy Management.*
2. *To learn about Design for Conservation of Energy materials.*
3. *To learn about Energy Audit and Market.*
4. *To learn about planning, utilization pattern and future strategy*
5. *To learn about Pros and Cons of the common methods of analysis*

COURSE OUTCOMES

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

1. *Understand the Initiating, Organizing and Managing, Energy Management Programs*
2. *Understand the concepts critical assessment of energy usage and Importance of energy management*
3. *Understand the concepts of Energy auditing.*
4. *Understand the relevant international standards and laws.*
5. *Understand the Planning and future strategy*

UNIT – I

Introduction: Principles of Energy Management – Managerial Objectives – Energy Management in Functional Areas like Manufacturing Industry, Process Industry, and Commerce – Government.

Energy Manager: Role of Energy Manager in each of this organization – Initiating, Organizing and Managing, Energy Management Programs

UNIT – II

Energy Conservation: Technologies for Energy Conservation – Design for Conservation of Energy materials – energy flow networks – critical assessment of energy usage – formulation of objectives and constraints .

Energy Conservation of alternative options: synthesis of alternative options and technical analysis of options – process integration.

UNIT – III

Energy Audit: Definition and Concepts, Types of Energy Audits–Basic Energy Concepts – Resources for Plant Energy Studies – Data Gathering – Analytical Techniques.

The Energy Market: Scope, Characterization of an Investment Project – Types of Depreciation – Time Value of money – budget considerations, Risk Analysis.

UNIT-IV

Methods of Evaluation of Projects: Payback – Annualized Costs – Investor's Rate of return – Present worth – Internal Rate of Return – Pros and Cons of the common methods of analysis – replacement analysis.

Energy Consultant: Need of Energy Consultant – Consultant Selection Criteria-Energy Regulatories- Institutions.

UNIT – V

Energy Conservation in Industries, Cogeneration, Combined heating and power systems, Relevant international standards and laws.

Alternative Energy Sources: Solar Energy – Types of devices for Solar Energy Collection – Thermal Storage System – Control Systems-Wind Energ y – Availability – Wind Devices – Wind Characteristics – Performance of Turbines and systems.

TEXT BOOKS

1. S. S. Thipse, *Energy Conservation and Management, Illustrated*, Alpha Science International Limited, 4th Edition, 2014.
2. K V Sharma, P Venkataseshaiah, *Energy Management and Conservation,* I K International Publishing House, Kindle 3rd Edition, 3 September 2011.

REFERENCES

1. Amlan Chakrabarti, *Energy Engineering and Management,* Kindle Edition, 30 January 2011**.**
2. S. K. Shukla, Jeewan V. Tirkey., *Energy Conversion and Management,* publisher Narosa, 3rd Edition, , 2010.
3. Craig B. Smith, Kelly E. Parmenter, *Energy Management Principles: Applications, Benefits, Savings* ,Elsevier, 2015.

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(19ME3122) ENERGY MANAGEMENT IN THERMAL SYSTEMS

COURSE OBJECTIVES

1. *To learn the present energy scenario and the need for energy conservation*
2. *To learn the instruments suitable for energy auditing*
3. *To learn the operation of thermal utilities along with energy conservation*
4. *To study the various means of energy transmission and their protection*
5. *To know the finance options for various thermal utilities and its returns calculation techniques*

COURSE OUTCOMES

1. *Students get an overview of energy, its importance and conservation*
2. *Students can audit the power plants with its parameters*
3. *Students understood the usage of energy in various thermal utilities*
4. *Students are aware of energy transmission and its protection*
5. *Students know about financial analysis techniques for energy utilities*

UNIT – I

Introduction: Energy Scenario – World and India, Energy Resources, Availability in India, Energy consumption pattern, Energy intensive industries – An overview, Energy conservation potential in various industries and commercial establishments.

Energy Conservation and Energy Efficiency – Needs and advantages, Energy auditing – types, methodologies, barriers, role of energy manager – Energy audit questionnaire – Energy Conservation Act 2003.

UNIT – II

Instruments for Energy Auditing: Instrument characteristics – Sensitivity, readability, accuracy, precision, hysteresis, error and calibration.

Measurement of flow, velocity, pressure, temperature, spesed, lux, power and humidity. Analysis of stack, water quality, power and fuel quality

UNIT – III

Thermal Utilities: Operation and Energy Conservation: (i) Boilers (ii) Thermic Fluid Heaters (iii) Furnaces (iv) Waste Heat Recovery Systems (v) Thermal Storage.

UNIT – IV

Thermal Energy Transmission / Protection Systems: Steam traps – Refractories – Optimum insulation thickness –Insulation – Piping design.

UNIT – V

Financial Management: Investment – need, appraisal and criteria.

Financial Analysis Techniques – Break even analysis – Simple payback period, return on investment, net present value, internal rate of return, cash flows, DSCR, financing options, ESCO concept.

TEXT BOOKS

1. S. S. Thipse, *Energy Conservation and Management*, Alpha Science International Limited, 2015 Edition, 2015
2. Amlan Chakrabarti, *Energy Engineering and Management*, PHI, Second Edition, 2018

REFERENCES

1. Craig B. Smith, Kelly E. Parmenter, *Energy Management Principles*, Elsevier publisher, Second Edition, 2015.
2. S. K. Shukla, Jeewan V. Tirkey, *Energy Conversion and Management*, Narosa publishing house, 2010 Edition, 2010.
3. K V Sharma P Venkataseshaiah, *Energy Management and Conservation*, I K International Publishing House, First Edition, 2011.

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(19ME3114) AIR-CONDITIONING SYSTEM DESIGN

COURSE OBJECTIVES

1. *To learn about* Psychrometric properties and processes
2. *To learn about* Cooling load Estimation.
3. *To learn about* Air–conditioning Systems.
4. *To learn about* Air–conditioning Components
5. *To know about Design conditions and load calculations.*

COURSE OUTCOMES

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

1. *Understand the Parameters influencing the Effective Temperature.*
2. *Understand the concepts summer, winter and year round air – conditioning systems.*
3. *Understand the terms used in Air-Conditioning*
4. *Understand the concepts of Humidification and dehumidification equipment.*
5. *Understand the Design conditions and load calculation*

UNIT – I

Air–Conditioning: Psychrometric properties and processes - Construction of Psychrometric chart.

Requirements of Comfort Air Conditioning: Thermodynamics of human body- Effective temperature and Comfort chart – Parameters influencing the Effective Temperature.

UNIT – II

Cooling Load Estimation: Occupants – equipments - heat gain due to infiltration - fan load - Fresh air load (Ventilation).

Air-Conditioning Systems: Summer - winter and year round air-conditioning systems.

UNIT – III

Terms in Air–Conditioning Systems: All Fresh air, Re-circulated air with and without bypass, with reheat systems.

Calculation of Bypass Factor, ADP, RSHF, ESHF and GSHF for different systems.

UNIT-IV

Components: Humidification and dehumidification equipment - Grills and diffusers – Fans and blowers.

UNIT-V

Design Conditions and Load Calculations: Air distribution, pressure drop - duct design - Performance & selection - noise control.

TEXT BOOKS

1. C.P. Arora, *Refrigeration and Air-conditioning*, Tata McGraw-Hill, 2000.
2. AHRI, *Refrigeration and air-conditioning*, Prentice Hall, New Delhi, 1993.
3. Norman C. Harris, "*Modern Air Conditioning*", New York, McGraw-Hill, 1974.

REFERENCES

1. Jones W.P., *Air Conditioning Engineering*, Edward Arnold Publishers Ltd., London, 1984.
2. Hainer R.W., Van Nostrand, *Control Systems for Heating Ventilation and Air-Conditioning*, Reinhold Co., 2009.

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(19ME3115) JET PROPULSION AND ROCKETRY

COURSE OBJECTIVES

1. *To learn about application, performance and characteristics of Jet Propulsion.*
2. *To learn about gas dynamics and blade*
3. *To learn about Rocketry, its reactions, cycles and their analysis*
4. *To learn about environmental considerations and applications of Solid propellant.*
5. *To learn about environmental considerations and applications of Liquid propellant.*

COURSE OUTCOMES

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

1. *Understand the improvement and applications of Jet Propulsion*
2. *Understand the concepts practical air cooled blades Combustion Systems*
3. *Understand the concepts of thermodynamic flow analysis of Jet Propulsion*
4. *Understand the environmental considerations and applications of Solid propellant.*
5. *Understand the environmental considerations and applications of Liquid propellant.*

UNIT - I:

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

UNIT – II

Principles of Jet Propulsion and Rocketry: Fundamentals of jet propulsion, Rocket sand air breathing jet engines – Classification – turbo jet, turbo fan, turbo propulsion, rocket (Solid and Liquid propellant rockets) and Ramjet engines.

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, A_c / A_t of a nozzle, Supersonic nozzle shape, non-adapted nozzles, summer field criteria, departure from simple analysis – characteristic parameters – characteristic velocity, specific impulse, total impulse, relationship between the characteristic parameters , nozzle efficiency, combustion efficiency and overall efficiency.

UNIT – III

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.

UNIT-IV

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 - 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.

UNIT-V

Liquid Rocket Propulsion System: Liquid propellants–classification, Mono and Bipropellants, 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.

TEXT BOOKS

1. Philip Hill & Carl Peterson, *Mechanics and Dynamics of Propulsion*, Pearson, 2nd Edition, 2009.
2. George P.Sutton, *Rocket propulsion elements*, Oscar Biblarz, 8th Edition,2012.
3. Nicholas Cumpsty,*Jet propulsion*, Cambridge University Press, 3rd Edition, 2003.

REFERENCES

1. B.Ganesan, *Gas Turbines*, TMH, 2010.
2. Khajuria & Dubey (Dhanpatrai) *Gas Turbines and Propulsive Systems*, Dhanpat Rai Publishing Co Pvt Ltd, 2013.
3. George P. Sutton & Oscar Biblarz, *Rocket propulsion*, John Wiley & Sons, 8th Edition, 2010.

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(19ME3123) FUELS AND COMBUSTION

COURSE OBJECTIVES

1. *To understand the Characterization of fuel*
2. *To understand the different types of solid & liquid fuels*
3. *To understand the various types of Gaseous fuels*
4. *To understand the combustion process*
5. *To understand the combustion equipment used in Coal Burning*

COURSE OUTCOMES

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

1. *Demonstrate the different Characterizations of fuels.*
2. *Describe the various properties of different solid & liquid fuels used in combustion*
3. *Have a broad knowledge on different types of gaseous fuels and their applications*
4. *Differentiate between different types of combustion process used in Industrial Application*
5. *Identify the applications of different types of combustion equipment used in coal burning.*

UNIT – I

Characterization: Fuels - Types and Characteristics of Fuels - Determination of Properties of Fuels - Fuels Analysis - Proximate and Ultimate Analysis - Moisture Determination - Calorific Value, 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

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

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

UNIT – III

Gaseous Fuel: Gaseous Fuel Classification - Composition & Properties - Estimation of Calorific Value - Gas Calorimeter - 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

Combustion, Stoichiometry & Kinetics : Stoichiometry – Mass Basis & Volume Basis – Excess Air Calculation – Fuel & Flue Gas Compositions - Calculations – Rapid Methods – Combustion Processes – Stationary Flame – Surface or Flameless Combustion – Submerged Combustion – Pulsating & Slow Combustion Explosive Combustion. Mechanism of Combustion – Ignition & Ignition Energy – Spontaneous Combustion – Flame Propagation – Solid, Liquid & Gaseous Fuels Combustion – Flame Temperature – Theoretical, Adiabatic & Actual – Ignition Limits – Limits of Inflammability. Thermo Chemistry - Equilibrium combustion products - Low temperature combustion products – High temperature combustion products.

UNIT – V

Combustion Equipments : Coal Burning Equipments – Types – Pulverized Coal Firing – Fluidized Bed Firing – Fixed Bed & Recycled Bed – Cyclone Firing – Spreader Stokers – Vibrating Grate Stokers – 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.

TEXT BOOKS

1. B.I. Bhatt and S.M. Vora, *Stoichiometry*, Tata Mcgraw Hill, 5th Edition, 2010
2. Blokh A.G., *Heat Transfer in Steam Boiler Furnace,* Hemisphere Publishing Corp, 1988

REFERENCES

1. Civil Davies, *Calculations in Furnace Technology*, Pergamon Press,1st Edition, 1970
2. Holman J.P., *Thermodynamics*, McGraw-Hill Inc., Fourth Edition, 1988
3. Samir Sarkar, *Fuels & Combustion*, , Orient Longman, 3rd Edition, 2009
4. Sharma SP., Mohan Chander, *Fuels & Combustion*, Tata Mcgraw Hill, 1984.

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(19ME3103) THERMAL ENGINEERING LAB

COURSE OBJECTIVES

1. *To learn about performance of Heat Exchangers & Flame propagation analysis of Gaseous fuels.*
2. *To learn about Heat Balance sheet*
3. *To learn about VCR engine*
4. *To learn about performance analysis on Heat Pipes*
5. *To Learn about the performance of Solar Flat plate collector*

COURSE OUTCOMES

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

1. *Demonstrate the Performance of Heat Exchangers & Flame propagation analysis of Gaseous fuel.*
2. *Describe the Heat Balance sheet of an Engine*
3. *Have a broad knowledge on VCR engine*
4. *Differentiate between the performance analysis of Heat Pipe and Air conditioning unit*
5. *Identify the applications of solar flat plate collector.*

List of Experiments

1. Performance of Heat Exchangers.
2. Flame propagation analysis of gaseous fuels.
3. Emission measurement of an I.C. Engine.
4. Heat Balance sheet, Volumetric Efficiency and air fuel ratio estimation of an I.C. Engine.
5. Performance test on variable compression ratio of diesel engines.
6. COP estimation of vapour compression refrigeration test rig.
7. Performance analysis of Air conditioning unit.
8. Performance analysis of heat pipe.
9. Solar Flat Plate Collector Performance.
10. Calibration of temperature measurement apparatus

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(19ME3104) COMPUTER AIDED ANALYSIS LAB

COURSE OBJECTIVES

1. *To learn about Structural Analysis of solid.*
2. *To learn about thermal analysis of 2D dimension component.*
3. *To understand the different kinds of analysis and apply the basic principles to find out the stress and other related parameters of bars, beams loaded with loading conditions.*
4. *To lean to apply the basic principles to carry out dynamic analysis to know the natural frequency of different kind of beams.*
5. *To acquire basic understanding of Modeling and Analysis software.*

COURSE OUTCOMES

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

1. *Understand the Analysis of a truss member under loading.*
2. *Understand the concepts Analysis of Tapered plate under transverse load.*
3. *Understand the concepts of the flow of incompressible gas through an S-bend for laminar flow.*
4. *Understand the air flow over a simple geometry (aero foil) in a wind.*
5. *Analyze the given problem by applying basic principle to solve and demonstrate 1D and 2D heat transfer with conduction and convection boundary conditions.*

I. Introduction to Analysis Software Package

II. Structural Analysis

1. Analysis of a rectangular plate with a hole.
2. Analysis of a truss member under loading.
3. Static Analysis of a Simply supported beam
4. Analysis of Tapered plate under transverse load

III. Thermal Analysis

1. Conductive Heat Transfer Analysis in Rectangular 2D Component
2. Conductive Heat Transfer Analysis in Different Geometry 2D Components

IV. Computational Fluid Dynamics

1. Determine the flow of incompressible gas through an S-bend for laminar flow.
2. Determine the flow of incompressible gas through an S-bend for turbulent flow.
3. Determine that of incompressible water flowing over a cylinder.
4. Determine air flow over a simple geometry (aero foil) in a wind tunnel (2-D).

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(19HS0818) ENGLISH FOR RESEARCH PAPER WRITING

COURSE OBJECTIVES

1. *To understand that how to improve writing skills and level of readability.*
2. *To learn about what to write in each section.*
3. *To understand the skills needed when writing a Title.*
4. *To ensure the good quality of paper at very first-time submission.*
5. *To know the strategies and techniques for preparing academic projects.*

COURSE OUTCOMES

1. *To recognize and demonstrate the style and conventions of research writing.*
2. *To improve the clarity and coherence of their written proposal.*
3. *Able to use a variety of sentence patterns.*
4. *To enhance their revision and proofreading skills.*
5. *To use effective strategies and techniques to construct their academic projects.*

UNIT-I

Planning and Preparation- Word Order- Breaking up long sentences- Structuring paragraphs and Sentences- Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

UNIT-II

Clarifying Who Did What- Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism- Sections of a Paper, Abstracts and Introduction.

UNIT-III

Review of the Literature,-Methods, Results, Discussion, Conclusions and The Final Check.

UNIT-IV

Key skills needed when writing Title- Key skills needed when writing abstract- Key skills needed when writing an Introduction- Skills when writing a Review of the Literature.

UNIT-V

Skills needed when writing the Methods- Skills needed when writing the Results- Skills needed when writing the Discussion- Skills needed when writing the Conclusions.

TEXT BOOKS

1. Adrian Wallwork *English for Writing Research Papers*, Springer New York Dordrecht.Heidelberg London, 2011.
2. Adrian Wallwork *English for Academic Correspondence and Socializing***,** Kindle Edition, 2011.

REFERENCES

1. Day R, *How to Write and Publish a Scientific Paper*, Cambridge University Press, 2006.
2. Highman N, *Handbook of Writing for the Mathematical Sciences*, SIAM, Highman's Books, 1998.
3. Goldbort R, *Writing for Science*, Yale University Press, 2006.

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(19ME3105) ADVANCED HEAT TRANSFER

COURSE OBJECTIVES

1. *To understand the modes of heat transfer.*
2. *To understand the* different types *of flow process*
3. *To understand the boiling and condensation*
4. *To understand the Heat Exchangers*
5. *To understand the radiation and heat exchangers*

COURSE OUTCOMES

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

1. Describe the various modes of heat transfer.
2. Differentiate between different flow process of forced and free convection
3. Have a broad knowledge on Pool Boiling and Nusselt's theory
4. Differentiate between LMTD and NTU Methods
5. Have a broad knowledge on the Radiant heat exchange in grey, non-grey bodies

UNIT- I

Brief Introduction to different **modes of heat transfer**; Conduction: General heat conduction equation.
Steady State Heat Transfer: Simplified heat transfer in 1D and 2D–Fins.
Transient heat conduction; Lumped system analysis- Heisler's charts-semi-infinite solid-use of shape factors in conduction – problem solutions

UNIT - II

Forced Convection: Flow over a flat plate: Critical Reynolds Number - - Methods to determine heat transfer coefficient: Analogy between heat and momentum transfer - Similarity Parameters - Analytical Methods - Exact and Integral methods - Application of empirical relations to various geometries for Laminar and Turbulent flows
Internal flows: use of empirical correlations. Reynolds – Colburn Analogy - Application of empirical relations to various geometries for Laminar and Turbulent flows.
Free convection: Integral analysis on laminar free convective heat transfer – Different geometries – combined free and forced convection

UNIT - III

Boiling and condensation: Pool Boiling–Boiling regimes-Correlations. Nusselt's theory of film condensation on a vertical plate – Assumptions and correlations of film condensation for different geometrics. Two phase flow mass transfer, cooling, fluidized bed combustion, Heat pipes.

UNIT - IV

Heat Exchangers: Design procedure - LMTD and NTU methods–Cross flow and 1 shell 2,4,6,8 pass heat exchangers – Use of charts and empirical correlations.

UNIT - V

Radiation Heat Transfer: Radiant heat exchange in grey, non-grey bodies, with transmitting, reflecting and absorbing media, specular surfaces, Radiation, shape factor, analogy, shields, Radiation of gases & vapours.

TEXT BOOKS

1. M. Necati Ozisik, *Heat Transfer*, TMH, 7th Edition, 2010
2. P.K.Nag, Heat *and Mass Transfer*, McGraw Hill Book Company, 3rd Edition, 2002

REFERENCES

1. J.P. Holman, Frank P. Incropera, David P. Dewitt, *Introduction to Heat Transfer*, 4th Edition, 2010
2. P.S. Ghoshdastidar, *Heat Transfer*, Oxford Press, 2008.
3. Holman.J.P, *Heat Transfer*, Tata Mc Graw Hill, 2002.
4. R.C. Sachdeva, *Fundamentals of Engineering Heat and Mass Transfer*, Wiley Eastern Ltd., India, 2006.

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(19ME3106) STEAM ENGINEERING

COURSE OBJECTIVES

1. *To learn about fundamentals of steam generation.*
2. *To learn about piping, insulation and its applications.*
3. *To learn about assessment of steam distribution losses, Steam leakages.*
4. *To learn about energy Conservation and Waste Minimization.*
5. *To learn about process instrumentation, control and monitoring.*

COURSE OUTCOMES

Students undergoing this course are able to

1. *Understand the combustion in boilers and flame temperature.*
2. *Understand the heat savings and application criteria*
3. *Understand the performance evaluation of accessories*
4. *Understand about conservation and waste minimization.*
5. *Understand the control and monitoring devices of boiler*

UNIT – I

Introduction: Fundamentals of steam generation - Quality of steam, Use of steam table, Mollier Chart – Boilers - Types, Mountings and Accessories.

Combustion in boilers: Determination of adiabatic flame temperature, quantity of flue gases, Feed Water and its quality, Blow down - IBR, - Boiler standards.

UNIT – II

Piping & Insulation: Water Line, Steam line design and insulation - Insulation-types and application, Economic thickness of insulation - Heat savings and application criteria **Refractory:** types, selection and application of refractory - Heat loss.

UNIT – III

Steam Systems: Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system - Steam Engineering Practices; Steam Based Equipment / Systems.

UNIT – IV

Boiler Performance Assessment: Performance Test codes and procedure - Boiler Efficiency - Analysis of losses - performance evaluation of accessories - factors affecting boiler performance.

UNIT – V

Energy Conservation and Waste Minimization: Energy conservation options in Boiler - waste minimization, methodology - Economical viability of waste minimization.

Instrumentation & Control: Process instrumentation - control and monitoring - Flow, pressure and temperature measuring and controlling instruments, its selection.

TEXT BOOKS

1. A. McConkey & T. D. Estop, *Applied Thermodynamics*, Parson Publication, 2009.
2. Domkundwar, *A Course in Power Plant Engineering*, Dhanapat Rai and Sons, 2010.

REFERENCES

1. *Energy Efficiency in Thermal Utilities;* Book II Bureau of Energy Efficiency, 2010.
2. *Energy Performance Assessment for Equipment & Utility Systems*; Book IV- Bureau of Energy Efficiency,2008.
3. P. Chatopadhyay, *Boiler Operation Engineering*; Tata McGraw Hill Education Pvt. Ltd., 2007.

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(19ME3116) REFRIGERATION AND CRYOGENICS

COURSE OBJECTIVES

1. *To learn about the refrigeration and its units*
2. *To understand the performance characteristics of compressor*
3. *To learn about the various alternative refrigerants*
4. *To learn about the liquefactions of gases*
5. *To understand the properties of metals when at low temperatures.*

COURSE OUTCOMES

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

1. *Understand the working principle of refrigerator*
2. *Understand the design, selection of evaporators, condensers, control systems*
3. *Understand the different types of refrigeration systems.*
4. *Understand the concept of insulation.*
5. *Understand the concept of cryogenic system*

UNIT – I

Introduction: Necessity of low temperature - Vapour compression refrigeration - Multistage compression with inter-cooling, Multi-evaporator systems - Cascade systems - Manufacturing of dry ice.

UNIT – II

Types of Compressor: Performance characteristics and capacity control of reciprocating compressor, centrifugal compressors, screw compressor and scroll compressor.

UNIT – III

Design and selection of Devices in Refrigerator: evaporators – condensers - control systems – motors.

Types of Refrigerants: Refrigerants - alternative refrigerants - CFC/HCFC phase-out regulations - Refrigeration applications - food preservation - transport.

UNIT – IV

Insulation: Low temperature insulation-reflective-Evacuated powders- Rigid forms- super Insulation.

Cooling by adiabatic demagnetization- Gas separation and Cryogenic systems- Air separating- storage and handling of cryogenic liquids.

UNIT – V

Liquification of Gases: Air - Linde system- Analysis- Dual pressure cycle analysis- Liquefaction of Hydrogen and Helium-problems.

Effects on the properties of metals: Strength-Thermal properties-super conductivity-super fluidity - Application of Lower temperatures.

TEXT BOOKS

1. Marshall Sitting, *Cryogenic Research and Applications*, Von Nostrand Inc, New Jersey, 2001
2. B.A.Hands, *Cryogenics Engineering,* Academic Press, 1996

REFERENCES

1. B.A.Hands, *Principles of Refrigeration*, Pearson Education Asia, 2001.
2. C.P.Arora, *Refrigeration and Air-conditioning*, Tata McGraw-Hill, 2000.
3. R. B. Scott, *Cryogenics Engineering*, Von Nostrand Inc, New Jersey, 1999
4. K.D.Timmerhaus & TM Flynn, *Cryogenics process Engineering*, Plenum press, 1998
5. J.L.Threlkeld, *Thermal Environmental Engineering,* Prentice Hall, 1970

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(19ME3117) DESIGN OF HEAT EXCHANGERS

COURSE OBJECTIVES

1. *To learn about the various classifications of heat exchangers.*
2. *To know about the Design methodology and fouling factors of heat exchangers.*
3. *To gain Knowledge on Double pipe Heat Exchangers*
4. *To understand the concepts of design of Compact & Shell and Tube heat exchangers*
5. *To learn about the Mechanical Design of Heat Exchangers.*

COURSE OUTCOMES

Students undergoing this course

1. *Learns about the various classifications of heat exchangers.*
2. *Understands the Design methodology and fouling factors of heat exchangers.*
3. *Knows about Double pipe Heat Exchangers.*
4. *Understand the concepts of design of Compact & Shell and Tube heat exchangers*
5. *Gains Knowledge on Mechanical Design of Heat Exchangers.*

UNIT – I

Heat Exchangers:

Classification According to Transfer Process: Number of fluids - Surface compactness and construction features - Tubular heat exchanger - Plate type heat exchangers - Extended surface heat exchangers - Heat pipe - Regenerators.

Classification According to Flow Arrangement: Counter flow - Parallel flow - Cross flow exchanger.

UNIT – II

Heat Exchanger Design Methodology: Assumption for heat transfer analysis - Problem formulation - e-NTU method - *P*-NTU method - Mean temperature difference method.

Fouling of Heat Exchanger: Effects of fouling - Categories of fouling - Fundamental processes of fouling.

UNIT – III

Double Pipe Heat Exchangers: Thermal and Hydraulic design of inner tube - Thermal and hydraulic analysis of Annulus - Total pressure drop.

UNIT – IV

Compact Heat Exchangers: Thermal and Hydraulic design of Compact heat exchangers.

Shell and Tube Heat Exchangers: Tinker's, kern's, and Bell Delaware's methods for thermal and hydraulic design of Shell and Tube heat exchangers.

UNIT – V

Mechanical Design of Heat Exchangers: Design standards and codes - Key terms in heat exchanger design - Material selection and thickness calculation for major components such as tube sheet, shell, tubes, flanges and nozzles.

Introduction to Simulation and Optimization of Heat Exchangers - Flow induced vibrations.

TEXT BOOKS

1. Ramesh K. Shah and Dusan P. Sekulic, *Fundamentals of Heat Exchanger Design*, John Wiley & sons Inc., 2nd Edition, 2003.
2. D.C. Kern, *Process Heat Transfer*, McGraw Hill, Student Edition, 2009.

REFERENCES

1. Sadik Kakac and Hongton Liu, *Heat Exchangers: Selection, Rating and Thermal Design*, CRC Press, 3rd Edition, 2012.
2. A .P. Frass and M.N. Ozisik , *Heat Exchanger Design*, McGraw Hill, Reprint Edition, 1984
3. T. Kuppan, *Hand Book of Heat Exchanger Design, T.E.M.A. Standard*", New York, 1999.
4. G. Walker, *Industrial Heat Exchangers-A Basic Guide*, Hemisphere Pub, 2nd Edition 1990.

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(19ME3124) CRYOGENIC ENGINEERING

COURSE OBJECTIVES

1. *To Provide Introductory knowledge of Cryogenic Engineering Materials and Applications*
2. *To impart acquaintance in liquefaction of cryogenics gases and working of Cryocoolers.*
3. *To have familiarization of Cryogenic gases separation and purification for the Applications*
4. *To have through understanding of Cryogenic Refrigerators and its classification*
5. *To provide knowledge on the instruments, insulations used in the cryogenic systems*

COURSE OUTCOMES

On completion of this course the student will be able

1. *To have through knowledge on material properties for cryogenic applications*
2. *To know about the liquefaction of cryogenic fluids and its applications*
3. *To disseminate the methods of separation of cryogenic gases and purification*
4. *To understand the working of cryogenic refrigerators and its classification*
5. *To identify the methods of handling cryogenic fluids with insulations and instrumentation*

UNIT – I

Introduction: Insight on Cryogenics - Properties of Cryogenic fluids - Material properties at Cryogenic Temperatures - Applications of Cryogenics - Space Programs, Medical fields - Superconductivity - Cryo-metallurgy.

UNIT – II

Liquefaction Cycles: Liquefaction Cycles - Carnot, F.O.M. and Yield Cycles - Inversion Curve - Joule Thomson Effect - Linde Hampson Cycle, Precooled Linde Hampson Cycle, Claudes Cycle Dual Cycle, Eollins cycle, Simpson cycle - Ortho-Para hydrogen conversion - Critical Components in Liquefaction Systems.

UNIT – III

Separation of Cryogenic Gases: Binary Mixtures, T-C and H-C Diagrams, Principle of Rectification, Rectification Column Analysis - McCabe Thiele Method - Adsorption Systems for purification.

UNIT – IV

Cryogenic Refrigerators: J. T. Cryocoolers, G.M. Cryocoolers - Sterling Cycle Refrigerators, Pulse Tube Refrigerators, Dilution refrigerators, Magnetic Refrigerators - Regenerators used in Cryogenic Refrigerators

UNIT – V

Handling of Cryogens: Cryogenic Dewar, Cryogenic Transfer Lines. Insulations used in Cryogenic Systems, Instrumentation to measure Flow, Level and Temperature.

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TEXT BOOKS

1. Klaus D. Timmerhaus, Richard P. Reed, *Cryogenic Engineering,* Springer publication, 1st Edition, 2007
2. Mamata Mukhopadhya, *Fundamentals of Cryogenic Engineering,* PHI publication, Kindle Edition, 2010

REFERENCES

1. J. G. Weisend, *The Handbook of Cryogenic Engineering,* Taylor & Fransis publication,1 Edition, 1998
2. Radall F Barron, *Cryogenic Heat transfer,* Taylor & Fransis publication, 2nd Edition,1998
3. G.Venkatarathnam, *Mixed Refrigerant Processes*, Springer Publication, 2nd Edition, 2010.

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(19ME3118) COMPUTATIONAL FLUID DYNAMICS

COURSE OBJECTIVES

1. *To learn about basics of CFD*
2. *To learn about the basic governing equations*
3. *To learn about geometry modeling and Grid Generation*
4. *To learn about CFDHT Methodology*
5. *To learn about Solution of N-S Equations for Incompressible Flows*

COURSE OUTCOMES

Students undergoing this course are able to Understand

1. *The experimental and hyperbolic equations.*
2. *The FDM, FVM Methodology and finite volume methods.*
3. *The flow domains, mesh and their importance.*
4. *The Diffusion Equation, Convection Equation*.
5. *The Staggered & Non Staggered Grid Systems.*

UNIT – I

Introduction to CFD: CFD – with experimental and Hyperbolic Equations – Computational approach to Fluid Dynamics & its comparison analytical methods
Basics of PDE: Elliptic, Parabolic.

UNIT – II

Governing Equations: Review of Navier-Stokes Equation & simplified forms – Solution Methodology – FDM & FVM with special emphasis on FVM, Stability, Convergence & Accuracy.
Finite Volume Method: Domain discretization – types of mesh – quality of mesh, simple, pressure velocity coupling, Checkerboard pressure field & staggered grid approach

UNIT – III

Geometry Modeling and Grid Generation: Practical aspects of computational modeling of flow domains – Grid Generation – Types of mesh – selection criteria, Mesh quality, Key parameters & their importance

UNIT – IV

Methodology of CFDHT: Objectives & importance of CFDHT – CFDHT for Diffusion Equation, Convection Equation & Convection-Diffusion Equation

UNIT – V

Solution of N-S Equations for Incompressible Flows: Semi-Explicit & Semi-Implicit – Algorithms for Staggered Grid System & Non Staggered Grid System of N-S Equations for Incompressible Flows

TEXT BOOKS

1. Atul Sharma, *Introduction to Computational Fluid Dynamics: Development, Application and Analysis,* John Wiley & Sons, 1st Edition , 2017.
2. T. J. Chung, *Computational Fluid Dynamics,* Cambridge University Press, 2nd Edition, 2017.

REFERENCES

1. Oleg Zikanov, *Essential Computational Fluid Dynamics,* John Wiley & Sons, 2nd Edition, 2019.
2. John F Wendt, *Computational Fluid Dynamics,* Springer Science & Business Media, 3rd Edition, 2008.
3. Frederic Magoules, *Computational Fluid Dynamics,* CRC Press, 1st Edition, 2011.
4. Rainald Löhner, *Applied Computational Fluid Dynamics Techniques: An Introduction Based on Finite Element Methods,* John Wiley & Sons, 2nd Edition, 2008.

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(19ME3119) MODELLING OF I.C ENGINES

COURSE OBJECTIVES

1. *To learn the combustion chamber modeling*
2. *To learn about Thermodynamic Combustion Models of CI Engines.*
3. *To learn about fuel spray behavior, structure.*
4. *To learn about Modeling of charging system*
5. *To learn about Simulation of Otto cycle*

COURSE OUTCOMES

Students undergoing this course are able to

1. *Understand the approaches of modeling, model building and integration methods*
2. *Understands the thermodynamic models of CI engines.*
3. *Understand the concept fuel spray behavior, turbulent interactions.*
4. *Understand the Mathematical models of SI Engines*
5. *Understand the modelling of charging systems.*

UNIT – I

Fundamentals: Governing equations - Equilibrium charts of combustion chemistry, chemical reaction rates, and approaches of modeling, model building and integration methods.

Gas Exchange: Through valves, engine and porting geometry - exhaust gas recirculation - valve lift curves.

UNIT – II

Thermodynamic Combustion Models of CI Engines: Single zone models, premixed and diffusive combustion models - combustion heat release using wiebe function

Wall Heat Transfer Correlations: Ignition delay, internal energy estimations - two zone model - application of heat release analysis.

UNIT – III

Fuel Spray Behavior: Fuel injection - spray structure - fuel atomization - droplet turbulence interactions - droplet impingement on walls.

UNIT – IV

Modeling of Charging System: Constant pressure and pulse turbo charging - compressor and turbine maps - charge air cooler.

UNIT – V

Mathematical Models of SI Engines: Simulation of Otto cycle - at full throttle, part throttle and supercharged conditions - Progressive combustion - Auto ignition modeling - single zone models, mass burning rate estimation, SI Engine with stratified charge.

Friction - in pumping, piston assembly, bearings and valve train etc. - friction estimation for warm and warm up engines.

TEXT BOOKS

1. Haywood, *I.C. Engines*, Mc Graw Hill, 2001.
2. Ramos J, *Internal Combustion Engine Modeling*, Hemisphere Publishing Company, 2009

REFERENCES

1. V. Ganesan, *Internal Combustion Engines*, Tata McGraw Hill, New Delhi, 1996
2. P.A. Lakshmi Narayanan and Y. V. Aghav, *Modeling Diesel Combustion*, Springer, 2010
3. Bernard Challen and Rodica Baranescu, *Diesel Engine Reference Book*, Butterworth-Heinemann, 1999.

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(19ME3125) INSTRUMENTATION FOR THERMAL ENGINEERING

COURSE OBJECTIVES

1. *To provide knowledge on various measuring instruments for thermal engineering*
2. *To provide knowledge on microprocessor and element of microcomputer*
3. *To provide knowledge on advance measurement techniques*
4. *To understand the advance technique instruments*
5. *To understand the Measurement analyzers*

COURSE OUTCOMES

1. Student gets knowledge on characteristics of instruments and measuring instruments
2. The students acquire knowledge on microprocessor and element of micro computer
3. Students get knowledge on Measurement of Physical Quantities instruments
4. The Students are able to measure the advance technique instruments
5. The Students are acquire knowledge on Measurement analyzers

UNIT – I

Measurement Characteristics : 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

Microprocessors and Computers in Measurement: Data logging and acquisition – use of sensors for error reduction- elements of microcomputer interfacing- intelligent instruments in use.

UNIT – III

Measurement of Physical Quantities: Measurement of thermo-physical properties- instruments for measuring temperature, pressure and flow- use of sensors for physical variables

UNIT – IV

Advance Measurement Techniques: Shadowgraph – Schlieren – Interferometer - Laser Doppler Anemometer - Hot wire Anemometer- heat flux sensors- Telemetry in measurement

UNIT – V

Measurement Analysis: Chemical, thermal, magnetic and optical gas analyzers - measurement of smoke, Dust and moisture- gas chromatography- spectrometry- measurement of pH- Review of basic measurement techniques.

TEXT BOOKS

1. Barnery, *Intelligent Instrumentation,* Prentice Hall of India, 1988
2. Bolton.W, *Industrial Control & Instrumentation,* Universities Press, Second Edition, 2001

REFERENCES

1. Holman ,J.P., *Experimental methods for engineers*, McGraw-Hill, 2012
2. Doblin E.O, *Measurement System Application and Design*, McGraw Hill, Second Edition.
3. John G Webster, *The measurement, Instrumentation and sensors Handbook,* CRC and IEE Press, 1999
4. Morris A.S, *Principles of Measurements and Instrumentation,* Prentice Hall of India, 1998.

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(19ME3107) COMPUTATIONAL FLUID DYNAMICS LAB

COURSE OBJECTIVES

1. *To learn about the basic governing equations.*
2. *To learn about finite volume method.*
3. *To learn about Solution of N-S Equations for Incompressible Flows.*
4. *To provide the essential numerical background for solving the partial differential equations governing the fluid flow.*
5. *To develop students skills of using a commercial software package.*

COURSE OUTCOMES

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

1. *Understand the experimental and hyperbolic equations.*
2. *Understand the geometry modeling and Grid Generation.*
3. *Understand the methodology of computational fluid dynamics.*
4. *Understand both flow physics and mathematical properties of governing N-S equations and define proper boundary conditions for solution.*
5. *Use CFD software to model relevant engineering flow problems and analyze the CFD results.*

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=0.000217 m^2/s p=800 kg/m^2
2. Simulation of Couette flow when the upper plates are moving with a velocity of 40 m/s. Take the distance between the plates as 4 cm properties of fluid are v=0.000217 m^2/s, p=800 kg/m^3. Make simulations for a pressure gradient of 0-30000 $N/m^2/m$ and 20000 N m^2/m and report the variation of velocity contours for each case
3. Simulation of a channel flow (Tube flow) for a tube of diameter. 5 cm and take the fluid As water at 30^0C at the entry of the tube of length 0.7m. A heat flux of 3000 W/m^2 is Imposed along a wall. Obtain the contours of velocity and temperature along the length of the tube and also obtain the center line temperature and velocity of fluid.
4. Simulation of a channel flow (Tube flow) for a tube of diameter 5 cm and take the fluid as water at 30^0C at the entry of the tube length 0.7m . A Constant wall temperature of 300^0C is imposed along the wall. Obtain the contours of Velocity and temperature along the length of the tube and also obtain the center line temperature and velocity of fluid.
5. Unsteady simulation of compressible flow of air through 2D a convergent – 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 of velocity, pressure and Mach number.

6. Simulation of flow over a circular cylinder of size 5 cm for different Reynold's number values of air and plotting the contours of velocity and vorticity
7. Simulation of temperature counters for a square plate of size 0.2m subjected 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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(19ME3108) THERMAL ENGINEERING VIRTUAL LAB

COURSE OBJECTIVES

1. *To understand Rise of Taylor Bubble, Gas-Liquid Two-Phase Flow, Evaporation Loss.*
2. *To Learn about Characteristics of an Air Lift Pump, Conductivity Probes and Signals in Two-Phase Flow, Bubble Generation, Growth and Departure.*
3. *To Gain Knowledge on Steam Condensation, Two phase flow in a natural circulation loop and PV Diagram, load test, Torque crank angle curve on S.I engine.*
4. *To Know about the determination of cylinder Mean Effective Pressure and vibration analysis.*
5. *To Learn about the variation of exhaust noise and torsional vibration of an engine.*

COURSE OUTCOMES

Student undergoing this course

1. *Understands Rise of Taylor Bubble, Gas-Liquid Two-Phase Flow, and Evaporation Loss.*
2. *Learns about Characteristics of an Air Lift Pump, Conductivity Probes and Signals in Two-Phase Flow, Bubble Generation, Growth and Departure.*
3. *Gains Knowledge on Steam Condensation, Two phase flow in a natural circulation loop and PV Diagram, load test, Torque crank angle curve on S.I engine.*
4. *Understands about the determination of cylinder Mean Effective Pressure and vibration analysis.*
5. *Knows about the variation of exhaust noise and torsional vibration of an engine.*

Advanced Thermal Engineering Lab

1. Rise of Taylor Bubble through Vertical Circular Conduits.
2. Gas-Liquid Two-Phase Flow through a Vertical Tube.
3. Evaporation Loss from a Cryogenic Vessel
4. Characteristics of an Air Lift Pump
5. Conductivity Probes and Signals in Two-Phase Flow.
6. Bubble Generation, Growth and Departure from a Submerged Orifice.
7. Virtual Lab on Steam Condensation in Micro channels
8. Two phase flow in a natural circulation loop

Remote Triggered Virtual Lab on Automotive Systems

1. PV Diagram of a SI Engine
2. Torque Crank Angle Curve of a SI Engine
3. Load Test on a SI Engine
4. Mechanical Efficiency of a SI Engine
5. Determination of Cylinder Mean Effective Pressure.
6. Engine Health Monitoring by Vibration Analysis
7. Variation of Exhaust Noise with Engine Speed
8. Torsional Vibrations of an Engine

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(19HS0829) CONSTITUTION OF INDIA

COURSE OBJECTIVES

1. *To know the premises informing the twin themes of liberty and freedom from a civil rights perspective*.
2. *To address the growth of Indian opinion regarding modern Indian intellectuals constitutional role*
3. *To address entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.*
4. *To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution*
5. *To acquire knowledge for various competitive examinations*

COURSE OUTCOMES

1. *Explain the key concepts of political economy*
2. *Analyse the significant developments in the political ideologies*
3. *Describe the salient features of the constitution of India interpret, integrate and critically*
4. *Analyse the political economy of Indian international relations and gain knowledge in Judiciary system*
5. *Apply their knowledge and skills acquired to write various competitive examinations*

UNIT-I

Introduction to the Constitution

UNIT-II

Historical Perspective of the Constitution of India- Salient features and characteristics of the Constitution of India

UNIT-III

Scheme of the fundamental rights-The scheme of the Fundamental Duties and its legal status-The Directive Principles of State Policy – Its importance and implementation

UNIT-IV

Parliamentary Form of Government in India – Powers and Functions-The President of India - Status and Powers -The historical perspectives of the constitutional amendments in India-Judiciary system - Powers and Functions

UNIT-V

Local Self Government – Constitutional Scheme in India - Election Commission: Role and Functions

TEXT BOOKS

1. Government of India Ministry of Law and Justice (Legislative Department) , *The Constitution of India, 1950 (Bare Act)* Government Publication, 2015.
2. Dr. S. N. Busi, *Dr. B. R. Ambedkar framing of Indian Constitution*, 1st Edition, Government Publication 2015.

REFERENCES

1. M. P.Jain, *Indian Constitution Law*, Lexis Nexis 7th Edition, 2014.
2. D.D. Basu, *Introduction to the Constitution of India*, Lexis Nexis, 2015
3. P.M.Bakshi, *Constitution of India* Universal Law Publishing, 15th Edition,2018

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(19ME3120) DESIGN OF SOLAR AND WIND SYSTEMS

COURSE OBJECTIVES

The objective of the course is to make the students know the

1. *Alternative energy sources*
2. *Solar energy and Nuclear energy*
3. *Wind energy characteristics and Geothermal Energy*
4. *Availability of Hydrogen energy and Hydrogen production, storage methods*
5. *Direct energy conversion methods*
6. *Important parameters influencing the designing of solar and wind systems*

COURSE OUTCOMES

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

1. *Explain the Solar radiation estimation and measurement, solar energy collectors*
2. *Describe the Concept of Nuclear reactor, nuclear waste disposal*
3. *Classify the Methods of wind energy conversion systems and Geothermal Energy*
4. *Express the Production, storage methods of Hydrogen*
5. *Describe the Direct energy conversion methods.*
6. *Importance of Nuclear Waste Disposal from power plants*

UNIT - I

Introduction to conventional sources of energy, Alternative energy sources,
Solar Energy: solar radiation-capturing solar radiation-Types of collectors- concentric solar power-Applications. Solar radiation – Estimation, measurement, Solar energy utilization.

UNIT - II

Nuclear Energy: Potential of Nuclear energy, International Nuclear policies and regulations. Nuclear energy technologies – Fuel enrichment, Different types of Nuclear reactors, Nuclear waste disposal and nuclear fusion.

UNIT - III

Wind Energy: wind energy characteristics – Site location factors – Wind energy conversion systems –Betz model –applications
Geothermal Energy : Availability of Geothermal Energy-Size and distribution , Various types of systems to use geothermal energy , Direct heat applications , Power generation using geothermal heat, Sustainability of geothermal sources, Status of geothermal technology , Economics of geothermal energy.

UNIT - IV

Hydrogen Energy: Hydrogen as a renewable energy source, Hydrogen Fuel for vehicles.
Hydrogen Production: Direct electrolysis of water, thermal decomposition of water, biological and bio chemical methods of hydrogen production. Storage of Hydrogen: Gaseous, cryogenic and metal hydride

UNIT - V

Direct Energy Conversion: Introduction – Fuel cells – Thermo – electric energy – Magneto Hydrodynamic Generators – Photo voltaic cell.

TEXT BOOKS

1. N.K.Bansal and M.K Kleeman, *Renewable Sources of Energy and Conversion Systems*, 2007.
2. Duffie,*Principles of Thermal Process*, Beckman, 2nd Edition, 2010.

REFERENCES

1. Kreith and Kreider,*Solar Energy Handbook*, McGrawHill, 2006.
2. John Twidell& Tony Weir, *Renewable Energy Sources*, Taylor & Francis, 2006.
3. D.A.Maths ,*Hydrogen Technology for Energy*, Noyes Data Corp, 2002.
4. Linden ,*Batteries and Fuel cell hand book*, MC. Graw Gill, 2010.

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(19ME3126)FINITE ELEMENT METHODS IN THERMAL ENGINEERING

COURSEOBJECTIVES

Students undergoing this course are able to understand

1. *Basics of Finite Element Methods and its Governing equations*
2. *Governing equations for 1D structural problems*
3. *Boundary conditions & shape functions*
4. *Scalar field problems in steady state heat conduction*
5. *Computer implementation in solving the governing equations*
6. *Finite Element method application packages*

COURSE OUTCOMES

On successful completion of the course the Students will be able to

1. *Formulate the experimental and basic equations.*
2. *Describe the problems on bar, analysis of beams and frames.*
3. *Discuss the boundary layer condition and Numerical integration.*
4. *Explain the Generalist heat conduction equation.*
5. *Illustrate the processes mesh generation, boundary conditions.*
6. *Analyze the Analysis of Frames & Beams*

UNIT – I

Introduction to FEM: Basic concepts, application of FEM- General description, advantages of FEM, comparison of FEM with other methods - Finite difference method, Variational method, Galerkin Method, basic element shapes, interpolation function- Virtual Energy principle, treatment of boundary conditions, solution of system of equations, basic equations of elasticity, strain displacement relations.

UNIT – II

1-D Structural Problems: Axial bar element, stiffness matrix, load vector, temperature effects, quadratic shape function and analysis of trusses – Plane truss and space truss elements.

Analysis of Beams, Frames – Hermite shape functions, stiffness matrix, load vector problems, analysis.

UNIT – III

2-D Problems –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 – IV

Scalar Field Problems –Generalized Heat Conduction Equation–Variation Principle–Boundary Conditions – Internal heat generation, heat flux and convection - 1-DSteady state Heat conduction – Thermal load vector - 1-D fin element – Quadratic fin elements I

D unsteady state heat conduction – Thermal load vector - 2-D steady state heat conduction – Concepts of 3D heat conduction- Finite Element Formulation of Torsion, Potential flow, seepage and fluid flow in ducts.

UNIT – V

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

1. Tirupathi R. Chandrupatla and Ashok D.Belegundu,*Introduction to finite elements in engineering* , Pearson publication,2012
2. S.S. Rao, *An Introduction to Finite Element Methods*, Pegamon, New York

REFERENCES .

1. O.C. Aienkowitz,*The Finite element method in Engineering science*, , Mc. Graw Hill.
2. Lewis R.W, Morgan.K, ThomasH.R. and Seetharaman K.N,*The finite element method in Heat transfer analysis*-, John Wiley, 1994.

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(19ME3127) THERMAL MEASUREMENTS AND PROCESS CONTROLS

COURSE OBJECTIVES

Students undergoing this course are able to understand

1. *General concepts of Thermal Measurement and Process Controls*
2. *Measurement of pressure and calibration methods*
3. *The compressible fluid Flow measurement*
4. *The working principles of various temperatures Measuring Instruments*
5. *Measurement of Fluid Level and velocity measurements*
6. *The working of various process controls*

COURSE OUTCOMES

Upon completion of the course the Students will be able to

1. *Understand the basic Instruments and general concepts.*
2. *Describe the working of different Pressure Measurement Instruments.*
3. *Illustrate different working of Flow measurement*
4. *Discuss about the Generalist Temperature Measurement Instruments.*
5. *Differentiate the difference of Velocity and density Measurement.*
6. *Describe the working of water level measuring Instruments*

UNIT – I

General Concepts: Fundamental elements of a measuring instrument - Static and dynamic characteristics – Errors in instruments – Different methods of measurement and their analysis – Sensing elements and transducers.

UNIT – II

Measurement of Pressure: Principles of pressure measurement, static and dynamic pressure, vacuum and high pressure measuring – Measurement of low pressure, manometers- Calibration methods.

UNIT – III

Measurement of Flow: Obstruction meters, variable area meters. Pressure probes and their classification and applications .compressible fluid flow measurement, Thermal anemometers, calibration of flow measuring instruments.

UNIT – IV

Temperature Measurement: Different principles of Temperature Measurement, use of bimetallic thermometers – Mercury thermometers, Vapor Pressure thermometers-Thermo positive elements, thermocouples in series and parallel, measurement of heat flux-calibration of temperature measuring instruments- Measurement of thermal conductivity of solids, liquids and gases.

UNIT – V

Level Measurement: Direct and indirect methods, manometric methods, float level meters, electrical conductivity, Capacitive, Ultrasonic, and Nucleonic Methods.

Measurement of Density; Hydrometer, continuous weight method, Gamma rays, Gas impulse wheel.

Velocity Measurement; Coefficient of viscosity, Ostesld method, free fall of piston under gravity, torque method.

TEXTBOOKS

1. E.O. Doeblin,*Measurement System, Application and Design*, McGraw Hill Publications.
2. B.C.Nakara, KK Chaudhry, *Instrumentation &Measurement and analysis*, TMH Publications.

REFERENCES

1. R.K. Jain ,*Mechanical and Industrial Measurements* , Khanna Publishers.
2. Buck &Beckwith ,*Mechanical Measurements*, Pearson.
3. Bela.G.Liptak, ,*Process Measurement and analysis*,CRC Press publisher.

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(19HS0824) BUSINESS ANALYTICS

COURSE OBJECTIVES

Students undergoing this course are able to

1. *Understand the concepts and methods of business analytics.*
2. *To Gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.*
3. *Identify the management related issues and processes to resolve*
4. *Understand the significance of forecasting models helpful in decision making*
5. *To become familiar with processes needed to develop, report and analyze business data*

COURSE OUTCOMES

On successful completion of course student will be able to

1. *Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.*
2. *Design alternatives to solve business problems utilizing quantitative analysis, critical thinking and sound ethical decision making.*
3. *Summarize, process and transform data for obtaining meaningful conclusions*
4. *Interpret data using latest data analytics tools to address organizational problems*
5. *Organize and critically apply the concepts and methods of business analytics*
6. *Assess decision problems and build models for creating solutions using business analytical tools.*

UNIT-I

Business analytics: Overview of Business analytics - Scope of Business analytics - Business Analytics Process - Relationship of Business Analytics Process and organization - competitive advantages of Business Analytics - Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modeling, sampling and estimation methods overview.

UNIT-II

Trendiness and Regression Analysis: Modeling Relationships and Trends in Data - simple Linear Regression - Important Resources - Business Analytics Personnel - Data and models for Business analytics - problem solving - Visualizing and Exploring Data, Business Analytics Technology

UNIT III

Organization Structures of Business analytics: Team management - Management Issues - Designing Information Policy – Outsourcing - Ensuring Data Quality - Measuring contribution of Business analytics - Managing Changes - Descriptive Analytics - predictive analytics - predicative Modeling - Predictive analytics analysis - Data Mining - Data

Mining Methodologies - Prescriptive analytics and its step in the business analytics Process - Prescriptive Modeling - nonlinear Optimization.

UNIT IV

Forecasting Techniques: Qualitative and Judgmental Forecasting - Statistical Forecasting Models - Forecasting Models for Stationary Time Series - Forecasting Models for Time Series with a Linear Trend - Forecasting Time Series with Seasonality - Regression Forecasting with Casual Variables - Selecting Appropriate Forecasting Models - Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform - New-Product Development Model - Newsvendor Model - Overbooking Model - Cash Budget Model.

UNIT V

Decision Analysis: Formulating Decision Problems - Decision Strategies with the Outcome Probabilities - Decision Trees - The Value of Information - Utility and Decision Making - Recent Trends in Embedded and collaborative business intelligence - Visual data recovery - Data Storytelling and Data journalism.

TEXT BOOKS

1. S. Christian Albright & Wayne Winston, *Business Analytics: Data analysis & Decision making*, 6th Edition, Cengage Learning, 2019
2. James Evans, *Business Analytics*, 2nd Edition, Pearson Education, 2013.

REFERENCES

1. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, *Business analytics Principles, Concepts, and Applications*, 1st Edition, Pearson FT Press, 2014.
2. SeemaAcharya& RN Prasad, *Fundamentals of Business Analytics*, 2nd Edition, WILEY
3. GalitShmueli, Peter C. Bruce, Nitin R. Patel, *Data mining for business analytics: Concepts, Techniques and Applications in Microsoft Office Excel with XLMiner*, WILEY, 2008.

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(19CE1028) COST MANAGEMENT OF ENGINEERING PROJECTS

COURSE OBJECTIVES

The objective of the course is to

1. *Establish systems to help streamline the transactions between corporate support departments and the operating units*
2. *Devise transfer pricing systems to coordinate the buyer-supplier interactions between decentralized organizational operating units*
3. *Use pseudo profit centers to create profit maximizing behaviour in what were formerly cost centers*

COURSE OUTCOMES

On successful completion of the course, the student should be able to

1. *Summarize the concept of strategic cost management, strategic cost analysis – Target costing, life cycle costing and Kaizen costing and the cost drive concept.*
2. *Describe the decision-making; relevant cost, differential cost, incremental cost and opportunity cost, objectives of a costing system.*
3. *Summarize the meaning and different types of project management and project execution, detailed engineering activities.*
4. *Understand the project contracts*
5. *Describe the cost behavior and profit planning types and contents, Bar charts and Network diagram.*
6. *Analyze by using quantitative techniques for cost management like PERT/CPM*

UNIT-I

Introduction and Overview of the Strategic Cost Management Process

UNIT- II

Cost Concepts: Cost concepts in decision-making - Relevant cost - Differential cost - Incremental cost and Opportunity cost - Objectives of a Costing System - Inventory valuation - Creation of a Database for operational control - Provision of data for Decision Making

UNIT-III

Project Management: Project: meaning - Different types - why to manage - cost overruns centers - various stages of project execution: conception to commissioning - Project execution as conglomeration of technical and nontechnical activities - Detailed Engineering activities - Pre project execution main clearances and documents - Project team: Role of each member - Importance Project site: Data required with significance - Project contracts - Types and contents - Project execution Project cost control - Bar charts and Network diagram - Project commissioning: mechanical and process

UNIT- IV

Cost Behavior and Profit Planning: Cost Behavior and Profit Planning Marginal Costing - Distinction between Marginal Costing and Absorption Costing - Break-even Analysis - Cost-Volume-Profit Analysis - Various decision-making problems - Standard Costing and Variance Analysis - Pricing strategies: Pareto Analysis - Target costing - Life Cycle Costing - Costing of service sector - Just-in-time approach - Material Requirement – Planning - Enterprise Resource Planning -Total Quality Management and Theory of constraints - Activity-Based Cost Management - Bench Marking - Balanced Score Card and Value-Chain Analysis - Budgetary Control - Flexible Budgets - Performance budgets - Zero-based budgets- Measurement of Divisional profitability pricing decisions including transfer pricing

UNIT-V

Quantitative Techniques: Quantitative techniques for cost management - Linear Programming, PERT/CPM - Transportation Problems - Assignment problems – Simulation - Learning Curve Theory

TEXT BOOKS

1. Robert S Kaplan Anthony A. Alkinson, *Management & Cost Accounting*
2. N.D. Vohra, *Quantitative Techniques in Management*, Tata McGraw Hill Book Co. Ltd

REFERENCES

1. *Cost Accounting A Managerial Emphasis*, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster,*Advanced Management Accounting*
3. Ashish K. Bhattacharya, *Principles & Practices of Cost Accounting*,A. H. Wheeler publisher

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(19EE2128) WASTE TO ENERGY

COURSE OBJECTIVES

The objectives of this course is

1. *To learn different types of waste materials available for energy conversion*
2. *To understand Pyrolytic oil and gases*
3. *To introduce gasification methods for biomass*
4. *To learn concepts of biomass resources, combustion types and biogas plant technology*
5. *To make the student to visualize the analysis of biogas plant*
6. *To learn various properties of biogas*

COURSE OUTCOMES

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

1. *Analyze agro based, forest residue and industrial waste conversion processes.*
2. *Describe the Manufacture of Pyrolytic oils and gases*
3. *Discuss about the methods of Manufacture of charcoal and its applications*
4. *Understand various types of gasifiers operation*
5. *Understand inclined and fluidized bed combustors operation*
6. *Understand types of biogas plants and biomass energy programme*

UNIT-I

Introduction to Energy from waste: Classification of waste as fuel – Agro based- Forest residue- Industrial waste- MSW- conversion devices- Incinerators- Gasifiers-Digesters.

UNIT-II

Bio-mass Pyrolysis: Pyrolysis- Types- Slow-Fast- Manufacture of Charcoal- methods-yields and application. Manufacture of Pyrolytic oils and gases – yields and applications.

UNIT-III

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT-IV

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT-V

Properties of Biogas (Calorific Value and Composition) : Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct

combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

TEXT BOOKS

1. Desai, Ashok V ,*Non-Conventional Energy*, Wiley Eastern Ltd., 1990.
2. Khandelwal, K. C. and Mahdi ,*Biogas Technology - A Practical Hand Book* -, Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.

REFERENCES

1. ChallalD.S ,*Food, Feed and Fuel from Biomass*, IBH Publishing Co Pvt Ltd.,1991.
2. GD Roy, *Non-conventional Energy Sources*- Khanna Publishers, 6th Edition
3. Khahid Rehman Hekeem, Mohammad Jawald., Umar Rashid, *Biomass & Bioenergy,* Springer International Publishing Ltd.

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(19ME3121) INDUSTRIAL SAFETY

COURSE OBJECTIVES

The objective of this course is to

1. *Learn about Mechanical and electrical hazards.*
2. *Understand the Fundamentals of Maintenance Engineering.*
3. *Identify the importance of Wear, Corrosion and their prevention.*
4. *Explain the Fault Tracing concept of various instruments used*
5. *Know the terms Periodic and preventive maintenance*

COURSE OUTCOMES

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

1. *Explain the Points of factories act 1948 for health and safety.*
2. *Define the term Cost & its relation with replacement economy.*
3. *Recognize the Concept of Wear, Corrosion and its Prevention methods*
4. *Understand the Concept of sequence of fault finding activities and the importance of decision tree*
5. *Elaborate the importance of scheduled preventive maintenance of mechanical and electrical equipment.*
6. *Distinguish between Periodic and Preventive maintenance of equipments*

UNIT-I

Industrial Safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT-II

Fundamentals of Maintenance Engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT-III

Wear and Corrosion and Their Prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, Screw down grease cup, Pressure grease gun, Splash lubrication, Gravity lubrication, Wick feed lubrication, Side feed lubrication, Ring lubrication, Principle and factors affecting the corrosion-Types and corrosion prevention methods.

UNIT-IV

Fault Tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment, Types of faults in machine tools and their general causes.

UNIT-V

Periodic Maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use

Preventive Maintenance: Definition, need, steps and advantages, Program and schedule of preventive maintenance of mechanical and electrical equipment, Repair cycle concept and its importance.

TEXT BOOKS

1. Higgins & Morrow, *Maintenance Engineering Handbook,* Da Information Services, 1995
2. H. P. Garg, *Maintenance Engineering, S. Chand and Company,* 2nd Edition, 2010

REFERENCES

1. Audels, *Pump-hydraulic Compressors*, Mcgrew Hill Publication. 4th Edition,1993
2. Winterkorn, *Foundation Engineering Handbook,* Chapman & Hall London., 2005

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(19ME3021) ADVANCES IN OPERATIONS RESEARCH

COURSE OBJECTIVES

The objective of this course is to

1. *Enumerate the fundamentals of Linear Programming*
2. *Learn classical optimization techniques*
3. *Develop the best strategy of Game and identifying the Queuing theory.*
4. *Understand about sequence and optimum Duration of the Project*
5. *Develop the importance of Replacement models and Inventory control*
6. *Identify the critical path of the project for optimum project duration.*

COURSE OUTCOMES

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

1. *Create mathematical models of the real time situations.*
2. *Implement Transportation and Assignment problems to solve in real time industry*
3. *Choose the best strategy of Game and capable of identifying the suitable queuing Theory*
4. *Enumerate fundamental techniques and apply it to solve various optimization areas*
5. *Investigate, study, Apply knowledge in Replacement models and Inventory Control Models*
6. *Understand the Inventory control Models*

UNIT-I

Introduction to OR and Linear Programming: OR definition–Types of Operations Research models; Linear Programming- Problem Formulation, Graphical Method, Simplex Method, Big-M Method, Degeneracy - Problems

UNIT-II

Transportation Problem: Formulation; Initial Basic Feasible Solution-North-West Corner Rule, Least Cost Method, Vogel's Approximation Method Modified Distribution (MODI) Method, Unbalanced Transportation-Problem

Assignment Problem – Formulation, Optimal Solution -Traveling Salesman problem.

UNIT-III

Game Theory: Introduction – Minimax (Maximin) Criterion and Optimal Strategy, Saddle Point, Solution of Games with Pure Strategy and Mixed Strategies – 2 X 2 Games – Dominance Principle.

Queuing Theory: Introduction to queuing system–Service Channel, Arrival Pattern, Size of Population, Service Pattern, Queue Discipline, Customer Behavior, Probability Distribution-Birth & Death Process, Simple Problems on Single Service channel only.

UNIT-IV

Sequencing: Terminology - Johnson's Algorithm for n-jobs x 2 Machines and n-jobs x 3 machines models - Problems

PERT & CPM: Introduction, Difference between PERT and CPM, Terminology- Activities, Events, Predecessor, Early Start, Early Finish, Late Start & Late Finish Times, Earliest Occurrence and Latest Occurrence of the Event, Total Float, Free Float, Independent Float; CPM- Deterministic Model; PERT- Probabilistic Model, Critical Path, Optimal Project Duration, Least Possible Project Duration- Problems.

UNIT-V

Replacement: Failure Mechanism of Items**,** Types of Replacements- Individual Replacement policy, Group Replacement policy, Replacement of items fail suddenly – problems

Inventory: Necessity for maintaining inventory, inventory costs, classification of fixed order quantity inventory models, selective inventory management techniques.

TEXT BOOKS

1. *S D. SHARMA Operations Research KNRN Publications. 17th edition 2015*
2. *Hamdy A Taha , Operations Research Pearson Publications, 9 th edition 2015*

REFERENCES

1. *Manohar Mahajan Operations Research, Dhanpat Rai &Co, 3rd Edition, 2016*
2. *Er. Premkumar Guptha & Dr.D.S. Hira, Operations Research, S Chand publications, 4th Edition, 2012.*
3. *R Panneer selvam, Operations Research, PHI, 2nd edition, 2012.*

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II M.Tech - I Sem

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(19ME3022) COMPOSITE MATERIALS

COURSE OBJECTIVES

The objective of the course is to

1. *Understand the mechanical behavior of composite materials*
2. *Get an overview of the methods of manufacturing composite materials.*
3. *Know the fundamentals of composite materials.*
4. *Understand the fabrication and process of composites.*
5. *Recognize the applications of composite materials.*
6. *Understand the mechanics of composites in the manufacturing process*

COURSE OUTCOMES

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

1. *Explain the Fundamental concept of composite materials.*
2. *Classify different types of composite materials.*
3. *Describe the Fabrication and processing of composite materials.*
4. *Illustrate the Methods of preparation of Metal matrix Composites and polymer matrix composites*
5. *Discuss about the Mechanical behavior of composite materials.*
6. *Explain the application of composite materials.*

UNIT-I

Introduction to Composites: Fundamentals of composites – need– enhancement of properties – classifications —Introduction to Reinforcement composites–types. Applications.Fiber production techniques for glass, carbon and ceramic fibers –Resin materials-Types.

UNIT-II

Polymer Matrix Composites: Fabrication of PMC's ,Fabrication of Fibers, Plastic Fiber Forms, Pre-pregs, Molding Compounds-Processes, Lay-Ups, Filament Winding, Pultrusion, and Recycling. Matrix – Reinforcement Interface, Wet ability.

UNIT-III

MMC & CMC : Fabrication of MMC'S, Liquid Infiltration- Casting, Solid State Processes-Diffusion Bonding &In Situ Technique. Fabrication of CMC's, Hot-Pressing, Infiltration, In Situ Chemical reaction Techniques.CVD& CVI, Sol-gel.

UNIT-IV

Mechanics of Composites: Basic assumptions of laminated anisotropic plates, symmetric laminates, angle ply laminates, cross ply laminates, laminate structural moduli, evaluation of lamina properties, determination of lamina stresses, maximum stress and strain criteria, Von -Mises Yield criterion for isotropic materials, generalized Hill's criterion for

anisotropic materials, Tsai-Hill's criterion for composites, prediction of laminate failure, thermal analysis of composite laminates

UNIT-V

Applications of Composites: Applications of advanced composite materials-Environmental effects in Composites, Green composites, Synthesis and Properties of Nano composites. Surface Composites & Surface metal matrix composites: Need, Synthesis, Properties and applications.

TEXT BOOKS

1. Mathews F. L. and Rawlings R. D., *Composite Materials: Engineering and Science*, Chapman and Hall, London, England, 1st Edition, 1994.
2. Chawla K. K., *Composite materials*, Springer – Verlag, 2nd Edition, 1998.

REFERENCES

1. Clyne, T. W. and Withers, P. J., *Introduction to Metal Matrix Composites*, Cambridge University Press, 1993.
2. Strong, A.B., *Fundamentals of Composite Manufacturing*, SME, 2nd Edition, 1989.
3. Sharma, S.C., *Composite materials*, Narosa Publications, 4th Edition, 2000.

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(19ME3110) DISSERTATION PHASE-I

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(19ME3111) DISSERTATION PHASE-II