Detailed Curriculum for Master of Technology (M. Tech.) in Thermal Engineering

Semester - I

Course Code	Course Type	Course Name	L	T	P	Credit	Total Marks
MBS-101C	Core-1	Advanced Mathematical Methods in Engineering	4	0	0	4	100*(70+30)
MTE-101C	Core-2	Advanced Fluid Dynamics	4	0	0	4	100*(70+30)
MTE-101E	Professional Elective-1 (any one)	1. Thermodynamics and Combustion	4	0	0	4	100*(70+30)
MTE-102E		2. Energy Conservation and Management.					
MTE-103E		3. Thermal Energy Storage.					
MTE-104E	Professional Elective-2 (any one)	1.Air Conditioning System Design	4	0	0	4	100*(70+30)
MTE-105E		2. Gas Turbines					
MTE-106E		3.Nuclear Engineering					
MTE-101L	Lab-1	Thermal Engineering Lab Practice-I	0	0	4	2	100
MTE-102L	Lab-2	Thermal Engineering Lab Practice-II	0	0	4	2	100
MID-101F	Computer Skills 3 (Compulsory foundation)	Python Programming	4	0	0	4	100*(70+30)
		Total	**20**		**8**	**24**	**700**

*70(Theory) + 30(Internal Assessment)

Semester - II

Course Code	Course No.	Course Name	L	T	P	Credit	Total Marks
MTE-201C	Core-3	Advanced Heat Transfer	4	0	0	4	100*(70+30)
MTE-202C	Core-4	Steam Engineering	4	0	0	4	100*(70+30)
MTE-201E	Professional Elective-3 (any one)	1.Refrigeration and Cryogenics	4	0	0	4	100*(70+30)
MTE-202E		2.Design of Heat Exchangers					
MTE-203E		3.Rocket Propulsion					
MTE-204E	Professional Elective-4 (any one)	1.Computational Fluid Dynamics	4	0	0	4	100*(70+30)
MTE-205E		2.Modelling of IC Engines					
MTE-206E		3.Design of Solar Thermal Systems					
MTE-201S	Sessional-1	Term Paper Leading to Thesis	0	0	4	2	100
MTE-202S	Sessional-2	Design Project	0	0	4	2	100
	Total		**16**	**0**	**8**	**20**	**600**

*70(Theory) + 30(Internal Assessment)

Semester – III

Course Code	Course No.	Course Name	L	T	P	Credit	Total Marks
MTE-301S	Sessional-3	Thesis Report Interim	0	0	8	4	100
MTE-302S	Sessional-4	Thesis Seminar Interim (Presentation and Viva Voce)	0	0	8	4	200
MTE-303S	Sessional-5	Technical Communication	0	0	4	2	100
MTE-304S	Sessional-6	Workshop and Seminars-I	0	0	2	0	100
MTE-301E MTE-302E MTE-304E	Professional Elective-5 (any one)	Interdisciplinary Open Elective Offered by Other Departments	4	0	0	4	100*(70+30)
MID-301A	Audit Course	Research Methodology and IPR	2	0	0	0	100*(70+30)
	Total		**6**	**0**	**22**	**14**	**700**

*70(Theory) + 30(Internal Assessment)

Semester - IV

Course Code	Course No.	Course Name	L	T	P	Credit	Total Marks
MTE-401S	Sessional-7	Thesis Report Final	0	0	08	4	200
MTE-402S	Sessional-8	Thesis Seminar Final (Presentation and Viva Voce)	0	0	08	4	200
MTE-403S	Sessional-9	Workshop and Seminars-II	0	0	02	2	100
MDS-401O MDS-402O MVE-401O MVE-402O	Elective Paper (Offered by other department)	Interdisciplinary Open Elective Offered by Other Departments	4	0	0	4	100*(70+30)
MID-401F	Foundation Course	English for Research Paper Writing	2	0	0	0	100*(70+30)
MID-402F		Disaster Management					
MID-403F		Sanskrit for Technical Knowledge					
MID-404F		Value Education					
MID-405F		Constitution of India					
MID-406F		Pedagogy Studies					
MID-407F		Stress Management by Yoga					
MID-408F		Personality Development through Life Enlightenment Skills					
	Total		**6**	**0**	**18**	**14**	**700**

*70(Theory) + 30(Internal Assessment)

Semester – I

Core-1

Name of the course	Course Code	Time/ Duration	Credit
Advanced Mathematical Methods in Engineering	**MBS-101C**	**4 hrs/week**	**4**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Classify and solve ordinary differential equations of 1st and 2nd order.
CO-2	Solve problems in 1st and 2nd order linear partial differential equations.
CO-3	Compute expectations, variance, and correlation coefficients of a given probability distribution.
CO-4	Design various statistical techniques for solving mechanical problems.

Syllabus Contents:

MODULE-1	Ordinary Differential Equations: First-order equations (Linear, Equidimensional, Separable Exact, Homogeneous,); Second-order linear differential equations (homogeneous and nonhomogeneous); Solution methods such as undetermined coefficients and variation of parameters.
MODULE-2	Partial Differential Equations: First order partial differential equations; Second order linear partial differential equations, Canonical form, Fourier series, Second order equation, (Parabolic, Elliptic and Hyperbolic) in rectangular, cylindrical polar and spherical coordinate systems; Solution techniques such as separation of variables, eigen function expansions, integral transforms (Fourier and Laplace transforms); D'Alembert's solution for the Wave equation; Maximum principle for Elliptic equations; Variational methods for approximate solutions of differential equations.
MODULE-3	Standard discrete and continuous distributions like Binomial, Poisson, Normal, Exponential etc. Central Limit Theorem and its significance. Some sampling distributions like c2, t, F.
MODULE-4	ANOVA: One – way, Two – way with/without interactions, Latin Squares ANOVA technique, Principles of Design Of Experiments, some standard designs such as CRD, RBD, LSD. Some of the relevant topics required for ANOVA (sample estimates and test hypothesis) may also be included.

Books and References:

1. J.B. Doshi, "Differential Equations for Scientists and Engineers", Narosa, 2010.
2. Peter O'Neil, "Advanced Engineering Mathematics", Seventh Edition, Cengage Learning, 2012 (Indian Edition).

3. Michael Greenberg, "Advanced Engineering Mathematics", Second Edition, Pearson Education, 2002 (Indian Edition).
4. Jennings. A., Matrix Computation for Engineers and Scientists. John Wiley and Sons, 1992.
5. Prem.K.Kythe, Pratap Puri, Michael R.Schaferkotter, Introduction to Partial Differential Equations and Boundary Value problems with Mathematics, CRC Press, 2002.
6. Kreyszig, Erwin, I.S., Advanced Engineering Mathematics, Wiley, 1999.
7. Ramamurthy. V., Computer Aided Design in Mechanical Engineering., Tata McGraw Hill Publishing Co., 1987
8. Fundamental Concepts in the Design of Experiments, 5th Ed., by Hicks and Turner
9. Devore, Jay L., Probability and Statistics for Engineering and the Sciences, 5th edition, Brooks-Cole (1999)

Core-2

Name of the course	Course Code	Time/ Duration	Credit
Advanced Fluid Dynamics	**MTE-101C**	**4 hrs/week**	**4**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Understand and define the governing equations of fluid flow problems along with range of governing parameters and its solutions.
CO-2	Analyze the potential flow problems and boundary layer equations for approximate solutions.
CO-3	Analyze flow patterns of turbulent flow to solve problems of industrial base.
CO-4	Devise the experiments in the field of fluid mechanics.

Syllabus Contents:

MODULE-1	Governing equations in Fluid Dynamics: Derivation of Continuity and Momentum equations using integral and differential approach, dimensionless form of governing equations, special forms of governing equations, integral quantities, Exact Solutions of Navier-Stokes Equations: Fully developed flows, parallel flow in straight channel, Couette flow, Creeping flows.
MODULE-2	Potential Flow: Kelvin's theorem, Irrotational flow, Stream function-vorticity approach, Laminar Boundary layers: Boundary layer equations, flow over flat plate, Momentum integral equation for boundary layer, approximate solution methodology for boundary layer equations.
MODULE-3	Turbulent Flow: Characteristics of turbulent flow, laminar turbulent transition, time mean motion and fluctuations, derivation of governing equations for turbulent flow, shear stress models, and universal velocity distribution.

MODULE-4	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 Velocimetry.

Books and References:

1. Muralidhar and Biswas, Advanced Engineering Fluid Mechanics, , Alpha Science International, 2005
2. Irwin Shames, Mechanics of Fluids, , McGraw Hill, 2003
3. Fox R.W., McDonald A.T , Introduction to Fluid Mechanics, John Wiley and Sons Inc, 1985
4. Pijush K. Kundu, Ira M Kohen and David R. Dawaling, Fluid Mechanics, Fifth Edition, 2005

Professional Elective-1

Name of the course	Course Code	Time/ Duration	Credit
Thermodynamics and Combustion	**MTE-101E**	**4hrs/week**	**4**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Understand exergy, basic laws governing energy conversion in multi-component systems, entropy and transient flow.
CO-2	Emphasize on thermodynamic relations, equilibrium and stability of multiphase multi-component systems.
CO-3	Analyze the motion of combusting and non- combusting fluids.
CO-4	Apply the fundamental principles of statistical thermodynamics to non-ideal models of numerous engineering devices.

Syllabus Contents:

MODULE-1	First law and State postulates, Second law and Entropy, Availability and Irreversibility, Transient flow analysis.
MODULE-2	Nonreactive Ideal-Gas Mixture, PvT behaviour of Real gases, Real Gas mixture, and Generalized Thermodynamic Relationship.
MODULE-3	Combustion and Thermo-chemistry, Second law analysis of reacting mixture, Availability analysis of reacting mixture, Chemical equilibrium.
MODULE-4	Statistical thermodynamics, statistical interpretations of first and second law, Entropy, Third law of thermodynamics, and Nernst heat theorem.

Books and References:

1. Cengel, "Thermodynamics", Tata McGraw Hill Co., New Delhi, 1980.
2. Howell and Dedcius, "Fundamentals of Engineering Thermodynamics", McGraw Hill Inc., U.S.A.
3. Van Wylen & Sonntag, "Thermodynamics", John Wiley and Sons Inc., U.S.A.
4. Jones and Hawkings, "Engineering Thermodynamics", John Wiley and Sons Inc., U.S.A, 2004.
5. Holman, "Thermodynamics", McGraw Hill Inc., New York, 2002.
6. Faires V.M. and Simmag, "Thermodynamics", Macmillan Publishing Co. Inc., U.S.A.
7. Rao Y.V.C., "Postulational and Statistical Thermodynamics", Allied Publishers Inc, 1994.

Professional Elective-1

Name of the course	Course Code	Time/ Duration	Credit
Energy Conservation and Management	**MTE-102E**	**4 hrs/week**	**4**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Acquire insight about the energy scenario, utilization pattern and importance of energy management.
CO-2	Analyze about energy audit and energy economics.
CO-3	Apply the principles of energy conservation and cogeneration in industries.
CO-4	Emphasize on international standards and laws.

Syllabus Contents:

MODULE-1	The energy market, energy scenario, planning, utilization pattern and future strategy, Importance of energy management.
MODULE-2	Energy auditing- methodology and analysis, Energy economics.
MODULE-3	Energy conservation in industries, Cogeneration, Combined heating and power systems.
MODULE-4	Relevant international standards and laws.

Books and References:

1. L.C. Witte, P.S. Schmidt, D.R.Brown, “Industrial Energy Management and Utilization”, Hemispherical Publication, 1988.
2. Callaghan “Energy Conservation”.
3. D.A. Reeg, “Industrial Energy Conservation”, Pergamon Press, 1980.
4. T.L. Boyen, “Thermal Energy Recovery” Wiley, 1980.
5. L.J. Nagrath, “Systems Modeling and Analysis”, Tata McGraw Hill, 1982.
6. W.C. Turner, “Energy Management Handbook “, Wiley, New York, 1982.
7. I.G.C. Dryden, “The Efficient Use of Energy “, Butterworth, London, 1982.
8. R. Loftnen, Van Nostrarid Reinhold C. “Energy Handbook”, 1978.
9. TERI Publications.

Professional Elective-1

Name of the course	Course Code	Time/ Duration	Credit
Thermal Energy Storage	**MTE-103E**	**4 hrs/week**	**4**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Acquire the knowledge of various thermal energy storage systems.
CO-2	Identify the optimal (appropriateness, cost and sustainability) solutions to various thermal energy storage systems.
CO-3	Prepare and analyze the energy and exergy balance for various thermal energy storage systems.
CO-4	Generate the scenarios of recent advances in thermal energy storage methods, technologies with applications and predict the future trends.

Syllabus Contents:

MODULE-1	Energy Storage Systems (ESS) and Thermal Energy Storage (TES) methods: Introduction to ESS and TES, energy demand, energy storage, various energy storage methods, hydrogen for energy storage, comparison of energy storage technologies, thermal energy and TES, solar energy and TES, TES methods, sensible TES, latent TES, cold TES, seasonal TES, illustrative examples on PCM based latent TES and sensible TES for heating case studies.
MODULE-2	Thermal Energy Storage, Environmental Impact and Energy Savings: Introduction, major environmental problems, environmental impact and TES systems and applications, potential solutions to environmental problems, sustainable developments, energy savings, additional energy savings considerations for TES, energy conservation with TES, some limitations on increased efficiency, illustrative examples and case studies.
MODULE-3	

	Energy and Exergy analysis of TES Systems: Introduction, theory of energy and exergy analysis, thermodynamic considerations in TES evaluation, exergy evaluation of a closed TES system, appropriate efficiency measures for closed TES systems, importance of temperature in performance evaluations for sensible TES systems. Exergy based optimal discharged periods for closed TES systems.
MODULE-4	Recent advances in TES methods, technologies and applications: Introduction, recent TES investigations, developments in TES types and performance, micro- and macro-level advances in TES systems and applications, performance enhancement techniques, innovative applications of TES systems, advanced applications of exergy methods, illustrative examples, future outlook for TES.

Books and References:

1. Dincer I., and Rosen M. A. (2011); *Thermal Energy Storage: Systems and Applications*, Wiley
2. Huggins R. A. (2015); *Energy Storage: Fundamentals, Materials and Applications*. Springer
3. Robert A. Huggins (2015); *Energy Storage: Fundamentals, Materials and Applications*, Second Edition, Springer
4. Luisa F.Cabeza (2014); *Advances in Thermal Energy Storage Systems: methods and applications*, Elsevier
5. O'Hayre R., Cha S., Colella W., and Prinz F. B. (2009); *Fuel Cell Fundamentals*, Second Edition, Wiley
6. Narayan R. and Viswanathan B. (1998); *Chemical and Electrochemical Energy System*, Universities Press
7. Rahn C. D. and Wang C. (2013); *Battery Systems Engineering*, First Edition, Wiley
8. Moseley P. T., and Garche J. (2014); *Electrochemical Energy Storage for Renewable Sources and Grid Balancing*, Elsevier Science.
9. Miller F. P., Vandome A. F., and John M. B. (2010); *Compressed Air Energy Storage*, VDM Publishing.
10. Recent International Journal Papers on Thermal Energy Storage Systems (Reviews, Experimental, Mathematical Modelling, Simulations etc.)

Professional Elective-2

Name of the course	Course Code	Time/ Duration	Credit
Air Conditioning System Design	**MTE-104E**	**4 hrs/week**	**4**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Understand the construction, design features of air-conditioning system and various types of Air-conditioning process.
CO-2	Analyze various types of Air-conditioning process and its adoptability in the various environment and application areas.

CO-3	Design the parts of AC and prioritize various health issues.
CO-4	Analyze the performance of various air-conditioning system, selection procedure and noise control.

Syllabus Contents:

MODULE-1	Air conditioning systems, various air-conditioning processes.
MODULE-2	Enthalpy deviation curve, psychrometry, SHF, dehumidified air quantity, human comfort, indoor air quality.
MODULE-3	Design conditions and load calculations, air distribution, pressure drop, duct design, fans &, blowers.
MODULE-4	Performance & selection, noise control.

Books and References:

1. ASHRAE Handbook.
2. "Handbook of air-conditioning system design", Carrier Incorporation, McGraw Hill Book Co., U.S.A, 1965.
4. "Refrigeration and air-conditioning", ARI, Prentice Hall, New Delhi, 1993.
5. Norman C. Harris, "Modern Air Conditioning", New York, McGraw-Hill,1974.
6. Jones W.P., "Air Conditioning Engineering", Edward Arnold Publishers Ltd., London, 1984.
7. Hainer R.W., "Control Systems for Heating, Ventilation and Air-Conditioning", Van Nostrand
8. Reinhold Co., New York, 1984. 7. Arora C.P., "Refrigeration & Air Conditioning", Tata Mc Graw Hill, 1985.
9. Manohar Prasad, "Refrigeration & Air Conditioning", New Age Publishers.
10. Stoecker, "Refrigeration & Air Conditioning", Mc Graw Hill, 1992.
11. Stoecker, "Design of Thermal Systems", Mc Graw Hill, 1992.

Professional Elective-2

Name of the course	Course Code	Time/ Duration	Credit
Gas Turbines	**MTE-105E**	**4 hrs/week**	**4**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Understand thermodynamic cycles and Performance characteristics.
CO-2	Analyze gas dynamics, construction and design features of gas turbines as used for power generation.
CO-3	Design combustion system and practical air cooled blades.
CO-4	Analyze jet propulsion cycles and apply these for designing components with environmental consideration.

Syllabus Contents:

MODULE-1	Introduction, Cycles, Performance characteristics and improvement.
MODULE-2	Gas dynamics, centrifugal, axial and mixed flow compressor, principles and characteristics, turbine construction, blade materials, manufacturing techniques, blade fixing.
MODULE-3	Problems of high temperature operation, blade cooling, practical air cooled blades, combustion systems, various fuels and fuel systems.
MODULE-4	Jet propulsion cycles and their analysis, parameters affecting performance, thrust augmentation, environmental considerations and applications.

Books and References:

1. H Cohen, GFC Rogers and HIH Saravanamuttoo, "Gas Turbine Theory", Pearson Education, 2000.
2. V. Ganesan, "Gas Turbines", Tata McGraw Hill, 2003.
3. S.M.Yahya "Turbines, Compressors and Fans", Tata McGraw Hill, 1992.
4. Vincent "The theory and design of Gas Turbine and Jet Engines", McGraw Hill, 1950.
5. W W Bathic, "Fundamentals of Gas Turbines", John Wiley and Sons.

Professional Elective-2

Name of the course	Course Code	Time/ Duration	Credit
Nuclear Engineering	**MTE-106E**	**4 hrs/week**	**4**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Understand the basic concepts and processes taking place inside a nuclear reactor, such as nuclear fission, neutron production, scattering, diffusion, slowing down and absorption.
CO-2	Analyze the concepts of reactor criticality, the relationship between the dimension and fissile material concentration in a critical geometry.
CO-3	Analyze point kinetics equations, in hour equation and simple cases of reactivity additions.
CO-4	Apply the concepts of heat removal from reactor core, reactor safety and radiation protection.

Syllabus Contents:

MODULE-1	Radioactivity, nuclear reactions, cross sections, nuclear fission, power from fission, conversion, breeding, neutron transport equation, diffusion theory approximation.
MODULE-2	Fick's law, solutions to diffusion equation for point source, planar source, etc., energy loss in elastic collisions, neutron slowing down, solution of multigroup diffusion equations in one region and multiregion reactors, concept of criticality of thermal reactors.
MODULE-3	Derivation of point kinetics equations, inhour equation, solutions for simple cases of reactivity additions, fission product poison, reactivity coefficients.
MODULE-4	Solution of heat transfer equation in reactor core, temperature distribution, critical heat flux, reactor safety philosophy, defence in depth, units of radioactivity exposure, radiation protection standards.

Books and References:

1. Introduction to Nuclear Engineering (3rd Edition) by John R. Lamarsh, Anthony J.Barrata, Prentice Hall, (2001)
2. Introduction to Nuclear Reactor Theory, by John R. Lamarsh, Addison-Wesley, 1966)
3. Nuclear Reactor Analysis, by James J. Duderstadt and Lewis J. Hamilton, John Wiley(1976)
4. Nuclear Reactor Engineering,by S. Glasstone and A. Sesonske,
5. Fundamentals of Nuclear Science and Engineering, by J. Kenneth Shultis, Richard E, Faw, Richard E. Faw,
6. Nuclear Principles in Engineering, by Tatjana Tevremovic,
7. Nuclear Engineering by Kenneth D. Kok,
8. Nuclear Engineering Fundamentals, by Cacuci, Dan Gabriel,
9. Thermal Design of Nuclear Reactors, by R. H. S. Winterton.

Lab-1

Name of the course	Course Code	Time/ Duration	Credit
Thermal Engineering Lab Practice-I	**MTE-101L**	**4 hrs/week**	**2**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Acquire hands on experience on the various test-rigs, experimental set up.
CO-2	Measure the various technical parameters by instrument and by mathematical relationship.
CO-3	Identify the effect of various parameters on the system and able to co-relate them.
CO-4	Use modern engineering software tools to analyze the problems.

The lab practice consists of the tutorials and experiments as decided by the course supervisors of the Program Core Courses (PCC).

No of Experiments: Minimum Six experiments to be carried out.

Lab-2

Name of the course	Course Code	Time/ Duration	Credit
Thermal Engineering Lab Practice-II	**MTE-102L**	**4 hrs/week**	**2**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Acquire hands on experience on the various test-rigs, experimental set up.
CO-2	Measure the various technical parameters by instrument and by mathematical relationship.
CO-3	Identify the effect of various parameters on the system and able to co- relate them.
CO-4	Use modern engineering software tools to analyze the problems.

The lab practice consists of the tutorials and experiments as decided by the course supervisors of the Program Core Courses (PCC).

No of Experiments: Minimum Six experiments to be carried out.

(Compulsory foundation)

Name of the course	Course Code	Time/ Duration	Credit
Computer Skills 3 (Python Programming)	**MID-101F**	**4 hrs/week**	**4**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	**To realize basic programming skills in Python.**
CO-2	**Explore control structures and lists in Python**
CO-3	**To develop the ability to write functions in Python**
CO-4	**To acquire programming skills for file handling in Python.**

Syllabus Contents:

MODULE-1	Fundamental concepts: Literals, variables and identifiers, operators, expressions and data types.
MODULE-2	Control structures: Boolean expressions, selection control, iterative control; Lists: List structures, Lists, (sequences), iterating over lists.

MODULE-3	Functions: Program routines, calling value-returning functions, calling non value-returning functions, parameter passing, variable scope.
MODULE-4	Dictionaries and Sets; Recursion; Text Files: Using text files, string passing, exception handling.

Books and References:

1. Michael Urban and Joel Murach, Python Programming, Shroff/Murach, 2016

2. Mark Lutz, Programming Python, O`Reilly, 4th Edition, 2010

Semester-II

Core-3

Name of the course	Course Code	Time/ Duration	Credit
Advanced Heat Transfer	**MTE-202C**	**4 hrs/week**	**4**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Apply principles of heat transfer to develop mathematical models for steady and unsteady state heat conduction problems.
CO-2	Analyze free and forced convection problems involving complex geometries with proper boundary condition.
CO-3	Understand physical and mathematical aspects of boiling, condensation and two phase flow heat transfer.
CO-4	Design heat pipes and apply the concepts of radiation heat transfer for enclosure analysis.

Syllabus Contents:

MODULE-1	Conduction- one and two dimensional, fins, conduction with heat source, unsteady state heat transfer.
MODULE-2	Natural and forced convection, integral equation, analysis and analogies.
MODULE-3	Transpiration cooling, ablation heat transfer, boiling, condensation and two phase flow heat

	transfer, cooling, fluidized bed combustion.
MODULE-4	Heat pipes, radiation, shape factor, analogy, shields, radiation of gases & vapours.

Books and References:

1. J.P. Holman, "Heat Transfer", McGraw Hill Book Company, New York, 1990.
2. Incropera and Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley and Sons, NewYork, 2000.
3. Frank Kreith, "Principles of Heat Transfer", Harper and Row Publishers, New York, 1973.
4. Donald Q. Kern "Process Heat Transfer", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1975.
5. Gupta and Prakash, "Engineering Heat Transfer", New Chand and Bros, Roorkee (U.P.) India, 1996.
6. R.C. Sachdeva "Fundamentals of Engineering Heat and Mass Transfer", Wiley Eastern Ltd., India.

Core-4

Name of the course	Course Code	Time/ Duration	Credit
Steam Engineering	**MTE-203C**	**4 hrs/week**	**4**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Understand the fundamentals of steam generation, steam table, Mollier Chart, mountings, accessories and IBR boiler standards.
CO-2	Design a steam piping system, its components for a process and also design economical and effective insulation.
CO-3	Analyze distribution losses, leakages and trapping for steam based equipments or systems.
CO-4	Apply techniques, skills, and modern engineering tools necessary for boiler performance assessment.

Syllabus Contents:

MODULE-1	**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.
MODULE-2	**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.
MODULE-3	**Steam Systems:** Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, Steam Engineering Practices; Steam Based Equipments / Systems.

MODULE-4	**Boiler Performance Assessment:** Performance Test codes and procedure, Boiler Efficiency, Analysis of losses; performance evaluation of accessories; factors affecting boiler performance, energy conservation options in Boiler; waste minimization, methodology; economical viability of waste minimization.

Books and References:

1. T. D. Estop, A. McConkey, Applied Thermodynamics, Parson Publication
2. Domkundwar; A Course in Power Plant Engineering; Dhanapat Rai and Sons
3. Yunus A. Cengel and Boles, "Engineering Thermodynamics ",Tata McGraw-Hill Publishing Co. Ltd
4. Book II - Energy Efficiency in Thermal Utilities; Bureau of Energy Efficiency
5. Book IV - Energy Performance Assessment for Equipment & Utility Systems; Bureau of Energy Efficiency
6. Edited by J. B. Kitto & S C Stultz; Steam: Its Generation and Use; The Babcock and Wilcox Company
7. P. Chatopadhyay; Boiler Operation Engineering: Questions and Answes; Tata McGrawHill Education Pvt Ltd, N Delhi

Professional Elective-3

Name of the course	Course Code	Time/ Duration	Credit
Refrigeration and Cryogenics	**MTE-201E**	**4 hrs/week**	**4**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Learn the basics of refrigeration cycle and systems with its application area.
CO-2	Design the refrigeration systems through proper selection of compressors, evaporators and condensers.
CO-3	Learn about refrigerants, ODP, GWP and related environment issues.
CO-4	Analyze vapour absorption refrigeration, gas liquefaction systems and related applications.

Syllabus Contents:

MODULE-1	Vapour compression refrigeration, actual cycle, second law efficiency, multistage compression with inter-cooling, multi-evaporator systems, cascade systems.
MODULE-2	Performance characteristics and capacity control of reciprocating and centrifugal compressors, screw compressor and scroll compressor, design, selection of evaporators, condensers, control systems, motor selection.
MODULE-3	Refrigerants, alternative refrigerants, CFC/HCFC phase-out regulations, refrigeration applications, food preservation, transport.

MODULE-4	Introduction to vapour absorption refrigeration, single effect and double effect systems, gas liquefaction systems - Linde-Hampson, Linde dual pressure, Claude cycle.

Book and References:

1. 1. R.J.Dossat, "Principles of Refrigeration", Pearson Education Asia, 2001.
2. C.P.Arora, "Refrigeration and Air-conditioning", Tata McGraw-Hill, 2000.
3. Stoecker & Jones, "Refrigeration and Air-conditioning", McGraw Hill Book Company, New York, 1982.
4. Jordan & Priester, "Refrigeration and Air-conditioning".
5. A.R.Trott, "Refrigeration and Air-conditioning", Butterworths, 2000.
6. J.L.Threlkeld, "Thermal Environmental Engineering", Prentice Hall, 1970.
7. R.Barron, "Cryogenic systems", McGraw–Hill Company, New Yourk, 1985.
8. G.G.Hasseldon. "Cryogenic Fundamentals", Academic Press.
9. Bailey, "Advanced Cryogenics", Plenum Press, London, 1971.
10. W.F.Stoecker, "Industrial Refrigeration Handbook", McGraw-Hill, 1998.
11. John A.Corinchock, "Technician's Guide to Refrigeration systems", McGrawHill.
12. P.C.Koelet, "Industrial Refrigeration: Principles, Design and Applications", Macmillan, 1992.
13. ASHRAE HANDBOOKS (i) Fundamentals (ii) Refrigeration.
14. Graham Walker, "Miniature Refrigerators for Cryogenic Sensors and Cold Electronics", Clarendon Press, 1989

Professional Elective-3

Name of the course	Course Code	Time/ Duration	Credit
Design of Heat Exchangers	**MTE-202E**	**4 hrs/week**	**4**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Demonstrate a basic understanding of several types of heat exchangers.
CO-2	Analyze the heat exchanger design methodology and performance degradation of heat exchangers subject to fouling.
CO-3	Design and analyze shell-and-tube double pipe, compact and plate heat exchangers.
CO-4	Simulate and optimize the heat exchangers.

Syllabus Contents:

MODULE-1	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.

MODULE-2	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.
MODULE-3	Double Pipe Heat Exchangers: Thermal and Hydraulic design of inner tube, Thermal and hydraulic analysis of Annulus, Total pressure drop, Thermal and Hydraulic design of compact heat exchanger, Tinker's, kern's, and Bell Delaware's methods for thermal and hydraulic design of Shell and Tube heat exchangers.
MODULE-4	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.

Book and References:

1. 1. Ramesh K. Shah and Dusan P. Sekulic, "Fundamentals of Heat Exchanger Design" John Wiley & sons Inc., 2003.
2. D.C. Kern, "Process Heat Transfer", McGraw Hill, 1950.
3. Sadik Kakac and Hongton Liu, "Heat Exchangers: Selection, Rating and Thermal Design" CRC Press, 1998.
4. A .P. Frass and M.N. Ozisik, "Heat Exchanger Design", McGraw Hill, 1984
5. Afgan N. and Schlinder E.V. "Heat Exchanger Design and Theory Source Book".
6. T. Kuppan, "Hand Book of Heat Exchanger Design".
7. "T.E.M.A. Standard", New York, 1999.
8. G. Walkers, "Industrial Heat Exchangers-A Basic Guide", McGraw Hill, 1982.

Professional Elective-3

Name of the course	Course Code	Time/ Duration	Credit
Rocket Propulsion	**MTE-203E**	**4 hrs/week**	**4**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Understand the principles of Rocket propulsion.
CO-2	Analyze the performance of Rocket components.
CO-3	Select suitable solid, liquid and hybrid propellants for specific application.
CO-4	Evaluate the performance of Rocket engines.

Syllabus Contents:

MODULE-1	**Theory of rocket propulsion:** Motion of Bodies in space, Parameters describing motion of bodies, Newton's Laws of motion, Universal law of gravitational force, Gravitational field, Requirements of motion in space, Escape velocity, Freely falling bodies, Rocket principle and rocket equation, Mass

	ratio of rocket, Desirable parameters of rocket, Rocket having small propellant mass fraction, Propulsive efficiency of rocket, Performance parameters of rocket, Classification of rockets.
MODULE-2	**Rocket nozzle and performance :** Expansion of gas from a high pressure chamber, Shape of the nozzle, Nozzle area ratio, Performance loss in conical nozzle, Flow separation in nozzles, Contour or bell nozzles, Unconventional nozzles, Mass flow rates and characteristics velocity, Thrust developed by a rocket; Thrust coefficient, Efficiencies.
MODULE-3	**Chemical propellants:** Criterion for choices of propellants, Solid propellants, Liquid propellants, Hybrid propellants. **Solid propellant rockets:** Mechanism of burning and burn rate, Choice of index n for stable operation of solid propellant rockets, Propellant grain configuration, Ignition of solid propellant rockets, Pressure decay in chamber after propellant burnout, Action time and burn time, Factors influencing burn rate, Components of a solid propellant rocket.
MODULE-4	**Liquid propellant rockets:** Propellant feed system, Thrust chamber, Performance and choice of feed system cycle, Turbo pumps, Gas requirements for draining of propellants from storage tanks, Draining under microgravity condition, Trends in development of liquid propellant rockets. **Hybrid rockets:** Working principle, Choice of fuels and oxidizer, Future of hybrid rockets.

Book and References:

1. Barrere, M., Rocket Propulsion, EIsevier Pub. Co., 1990.

2. Sutton, G. P., Rocket Propulsion Elements, John Wiley, New York, 1993.

3. Ramamurthi K., Rocket Propulsion, Macmillan Publishers India Ltd., 2010

4. Feedesiev, V. I. and Siniarev, G. B., Introduction to Rocket Technology, Academic Press, New York, 2000.

5. Sarvanamuttoo, H.I.H., Rogers, G. F. C. and Cohen, H., Gas Turbine Theory, 6th Edition, Pearson PrenticeHall, 2008.

Professional Elective-4

Name of the course	Course Code	Time/ Duration	Credit
Computational Fluid Dynamics	**MTE-204E**	**4 hrs/week**	**4**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Compare experimental and analytical methods of fluid dynamics.
CO-2	Demonstrate domain discretization and its application.
CO-3	Analyze practical aspects of computational modeling of flow domains.
CO-4	Apply the concept of the subject Computational Fluid Dynamics as tool to solve the Heat Transfer and Fluid Mechanics related Industrial Problems.

Syllabus Contents:

MODULE-1	**Introduction to CFD and Governing Equations:** Computational approach to Fluid Dynamics and its comparison with experimental and analytical methods, Basics of PDE: Elliptic, Parabolic and Hyperbolic Equations. Review of Navier-Stokes Equation and simplified forms, Solution Methodology: FDM and FVM with special emphasis on FVM, Stability, Convergence and Accuracy.
MODULE-2	**Finite Volume Method:** Domain discretization, types of mesh and quality of mesh, SIMPLE, pressure velocity coupling, Checkerboard pressure field and staggered grid approach.
MODULE-3	**Geometry Modeling and Grid Generation:** Practical aspects of computational modeling of flow domains, Grid Generation, Types of mesh and selection criteria, Mesh quality, Key parameters and their importance.
MODULE-4	**Methodology of CFDHT:** Objectives and importance of CFDHT, CFDHT for Diffusion Equation, Convection Equation and Convection-Diffusion Equation. Semi-Explicit and Semi-Implicit Algorithms for Staggered Grid System and Non Staggered Grid System of N-S Equations for Incompressible Flows.

Books and References:

1. 1. Computational Fluid Dynamics, The Basic with applications by John A. Anderson, Jr., McGraw Hill International editions, Mechanical Engineering series.
2. Numerical Methods in Fluid Flow & Heat Transfer by Dr. Suhas Patankar.
3. An Introduction to Computational Fluid Flow (Finite Volume Method), by H.K. Versteeg, W.Malalasekera, Printice Hall
4. Computational Methods for Fluid Dynamics by Ferziger and Peric, Springer Publication.
5. An Introduction to Computational Fluid Mechanics by Chuen-Yen Chow,Wiley Publication.
6. Computational Fluid Flow & Heat Transfer by Murlidhar and Sundarrajan, Narosa Publication.

Professional Elective-4

Name of the course	Course Code	Time/ Duration	Credit
Modelling of IC Engine	**MTE-205E**	**4 hrs/week**	**4**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Understand governing equations, combustion chemistry and EGR.
CO-2	Analyze several types of engine models that will include zero dimensional thermodynamic model, one dimensional and multi-dimensional, single zone, two zone etc models.
CO-3	Analyze the behaviour of fuel spray for engines.
CO-4	Develop models and simulate them for diesel engine, petrol engine and gas engine.

Syllabus Contents:

MODULE-1	**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.
MODULE-2	**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.
MODULE-3	**Fuel spray behavior:** Fuel injection, spray structure, fuel atomization, droplet turbulence interactions, droplet impingement on walls, Modeling of charging system: Constant pressure and pulse turbo charging, compressor and turbine maps, charge air cooler.
MODULE-4	**Mathematical models of SI Engines**: Simulation of Otto cycle at full throttle, part throttle and supercharged conditions. Progressive combustion, Autoignition modelling, 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.

Books and References:

1. Haywood, "I.C. Engines", Mc Graw Hill.
2. Ramos **J** (1989**)** Internal Combustion Engine Modeling**.** Hemisphere Publishing Company
3. C. D. Rakopoulos and E. G. Giakoumis, "Diesel Engine Transient
4. Operation Principles of Operation and Simulation Analysis", Springer, 2009.
5. V. Ganeshan, "Internal Combustion Engines", Tata McGraw Hill, New Delhi, 1996.
6. P.A. Lakshminarayanan and Y. V. Aghav, " Modelling Diesel Combustion" Springer, 2010
7. Bernard Challen and Rodica Baranescu, "Diesel Engine Reference Book" Butterworth- Heinemann, 1999.

Professional Elective-4

Name of the course	Course Code	Time/ Duration	Credit
Design of Solar Thermal Systems	**MTE-206E**	**4 hrs/week**	**4**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Acquire the knowledge of different aspects and parameters of solar energy systems.
CO-2	Analyze the performance of various solar thermal systems.
CO-3	Design, test, model, optimize and analyze different solar drying systems and associated impacts.

CO-4	Generate the scenarios of recent advances and applications of SAH integrated with SHS and LHS in solar dryers and predict the future trends.

Syllabus Contents:

MODULE-1	**Basics of Solar Thermal Systems:** Introduction to Solar Air Heater (SAH)**,** Different components of SAH; Radiation transmission and absorption through glazing; Selective surfaces: Ideal coating characteristics, Anti reflection coating, application of SAH in solar drying systems and case studies.
MODULE-2	**Solar Air Heater or Collector and Thermal Energy Storage:** Flat Plate Collector: Theory and basic design aspects; Thermal analysis and effective heat loss; Performance analysis methods; Concentrating Collector: Classification of concentrating collector; concentrating collector configurations; Thermal performance of concentrating collector; Optical and thermal performance of different concentrating collector designs; Solar thermal energy storage: LSH and SHS materials, Designing thermal storage systems, recent advances in solar air heater methods, technologies with applications and future trends.
MODULE-3	**Solar Drying Systems:** Basic concepts and classifications of Solar Drying systems (SDS), design, testing and modelling of SDS, environomical impact of SDS, innovations in SDS, `4 E` analysis of SDS, heat and moisture transfer and optimization of SDS.
MODULE-4	**Applications of Solar Thermal Systems:** Performance evaluation of Solar Dryer with SHS and SAH: design, fabrication and detailed instrumentation of solar dryer, Mathematical modelling of SAH, Performance of SAH and Solar Dryer, Environomical analysis and future trends. Performance analysis of Solar Dryer integrated with LHS and SAH: design, fabrication and detailed instrumentation, energy and exergy analysis, performance test of solar dryer, future trends.

Books and References:

1. Duffie J. A. and Beckman W. A. (2013); *Solar Engineering of Thermal Processes*, John Wiley
2. Garg H. P. and Prakash S. (2000); *Solar Energy: Fundamental and Application*, Tata McGraw Hill
3. Nayak J. K. and Sukhatme S. P. (2006); Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw Hill
4. Twidell J, Weir T (2015); *Renewable Energy Resources*, Routledge
5. Dincer I., and Rosen M. A. (2011); *Thermal Energy Storage: Systems and Applications*, Wiley
6. Dinçer, İ. and Zamfirescu, C., 2016. *Drying phenomena: theory and applications*. John Wiley & Sons.
7. Prakash, O. and Kumar, A. eds., 2017. *Solar drying technology: concept, design, testing, modeling, economics, and environment*. Springer.
8. Ataer, O.E., 2009. Storage of thermal energy. Energy storage systems, 1, p.97.
9. Tyagi, H., Chakraborty, P.R., Powar, S. and Agarwal, A.K. eds., 2019. *Solar Energy: Systems, Challenges, and Opportunities*. Springer Nature.
10. Goswami D. Y. (2015); *Principles of Solar Eng*ineering, Taylor and Francis
11. Tiwari G. N. (2002); *Solar Energy: Fundamentals, Design, Modeling and Applications*,

Narosa

12. Sorensen B. (2010); *Renewable Energy*, Fourth Edition, Academic press

13. Recent International Journal Papers on Solar Air Heater (Reviews, Experimental, Mathematical Modelling, Simulations etc.)

Sessional-1

Name of the course	Course Code	Time/ Duration	Credit
Term Paper Leading to Thesis	**MTE-201S**	**4 hrs/week**	**2**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Identify the project of their expertise domain and interest.
CO-2	Explain the recent trend of research and its recent developments through literature survey
CO-3	Make an in-depth study of a specific topic within suitable engineering design and specifications.

Syllabus Contents:

The project topic should be selected / chosen to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study. The course should have the following-

1) Identification of domain for research.
2) Literature review.
3) In-depth study for suitable engineering design and specifications.

Sessional-2

Name of the course	Course Code	Time/ Duration	Credit
Project Design	**MTE-202S**	**4 hrs/week**	**2**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Outline the points to formulate problem corresponding to the project topic
CO-2	Develop know how to organize, scope, plan, do and act within a project thesis.
CO-3	Define problem specific tools (i.e. hardware equipment and software) and its functionality.

Syllabus Contents:

The project topic should be selected / chosen to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study. The course should have the following-

1) Problem formulation.
2) Knowledge of how to organize, scope, plan, do and act within a project thesis.
3) Familiarity with specific tools (i.e. hardware equipment and software) relevant to the project selected.

Semester – III

Sessional-3

Name of the course	Course Code	Time/ Duration	Credit
Thesis Report Interim	**MTE-301S**	**8 hrs/week**	**4**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Understand that how to write thesis with good readability
CO-2	Learn to write section wise.
CO-3	Understand the skills needed while writing a thesis
CO-4	Ensure the quality of thesis report

Syllabus Contents:

Module-1	Planning and Preparation, Clarifying contributions of other authors, summarizing your findings, paraphrasing and plagiarism, sections of your thesis.
Module-2	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check. key skills are needed when writing a thesis, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a review of the literature.
Module-3	Skills are needed when writing about the methods and results, skills are needed when writing the discussion, skills are needed when writing the conclusions.
Module-4	Useful phrases, how to ensure thesis is as good as it could possibly be the first-time thesis writing.

Sessional-4

Name of the course	Course Code	Time/ Duration	Credit
Thesis Seminar Interim (Presentation and Viva Voce)	**MTE-302S**	**8 hrs/week**	**4**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Synthesize knowledge and skills previously gained and applied to an in-depth study and execution of new technical problem.
CO-2	Identify from different methodologies, methods and forms of analysis to produce a suitable research design, and justify their design.
CO-3	Demonstrate the findings of their technical solution in a written report.
CO-4	Present the work in International/ National conference or reputed journals.

Syllabus Contents:

The dissertation / project topic should be selected / chosen to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study.

A. The dissertation should have the following-

i) Relevance to social needs of society
ii) Relevance to value addition to existing facilities in the institute
iii) Relevance to industry need
iv) Problems of national importance
v) Research and development in various domain

B. The student should complete the following:

i) Literature survey Problem Definition
ii) Motivation for study and Objectives
iii) Preliminary design / feasibility / modular approaches
iv) Implementation and Verification
v) Report and presentation

Sessional-5

Name of the course	Course Code	Time/ Duration	Credit
Technical Communication	**MTE-303S**	**4 hrs/week**	**2**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Understand that how to improve your writing skills and level of readability
CO-2	Learn about what to write in each section
CO-3	Understand the skills needed when writing a Title
CO-4	Ensure the good quality of paper at very first-time submission

Syllabus Contents:

Module-1	Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness. Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction
Module-2	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check. key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.
Module-3	Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions
Module-4	Useful phrases, how to ensure paper is as good as it could possibly be the first-time submission

BOOKS AND REFERENCES:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)

2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press

3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook.

4. Adrian Wall work, English for Writing Research Papers, Springer New York DordrechtHeidelberg London, 2011

Sessional-6

Name of the course	Course Code	Time/ Duration	Credit
Workshop and Seminars-I	**MTE-304S**	**2 hrs/week**	**0**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Follow discussions, oral arguments, and presentations, noting main points or evidence and tracking threads through different comments
CO-2	Prepare appropriately to participate effectively and offer substantive replies to others' arguments, comments, and questions, while remaining sensitive to the original speaker and the classroom audience
CO-3	Speak and debate with an appreciation for complex social and technical sensibilities
CO-4	Offer compelling, articulate oral arguments, showing an understanding of the unique demands of oral presentation as opposed to writing

Syllabus Contents:

1. Participate effectively in discussion of workshops and seminars [at least 02(two)].
2. Follow discussions, oral arguments, and presentations, noting main points or evidence and tracking threads through different comments and submit a comprehensive report to the department.
3. Demonstration of the ability to speak and defend (to be presented in the presentation seminar organized by the department).
4. Understanding of the unique demands of oral presentation as opposed to writing.(presentation skills will be evaluated)
5. Those who are unable to attend seminar / conferences/ workshops within the semester period needs to pass at least 01(one) NPTEL / MOOCs course of at least 04(four) weeks duration which should be relevant to project and thesis topic. Grade/ percentage of marks obtained in the NPTEL / MOOCs course examination will be proportionately taken into account for final evaluation of sessional -6.

Professional Elective-5

Name of the course	Course Code	Time/ Duration	Credit
Design and Analysis of Thermal Systems	**MTE-301E**	**4 hrs/week**	**4**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Formulation of design problems related to thermal Systems and Develop a mathematical model for a given problem.
CO-2	Solve practical problems using suitable optimization technique.
CO-3	Evaluate component with the help of thermo-economic variables
CO-4	Design of piping and pump systems

Syllabus Contents:

MODULE-1	**Thermal Systems**: Characteristics- formulation of design problem - Steps in the design process - Modeling of thermal systems – importance - Types of models – Mathematical Modeling, Exponential forms- Method of least squares - Counter flow heat exchanger, Evaporators and Condensers, Effectiveness, NTU, Pressure drop and pumping power.
MODULE-2	**Unconstrained Optimization Techniques:** Univariate, Conjugate Gradient Method and Variable Metric Method. **Constrained Optimization Techniques:** Characteristics of a constrained problem; Direct Method of feasible directions; Indirect Method of interior and exterior penalty functions.
MODULE-3	**Thermo-economic analysis and evaluation:** Fundamentals of thermo-economics, Thermo-economic variables for component evaluation; thermo-economic evaluation; additional costing considerations. **Thermo-economic optimization:** Introduction; optimization of heat exchanger networks; analytical and numerical optimization techniques; design optimization for the co-generation system-a case study; thermo-economic optimization of complex systems.
MODULE-4	**Design of piping and pump systems:-** Head loss representation ;Piping networks; Hardy – Cross method Generalized Hardy – Cross analysis; Pump testing methods; Cavitation considerations; Dimensional analysis of pumps; piping system design practice.

Books and References:

1.Thermal Design & Optimization - Bejan, A., et al., John Wiley, 1996.

2. Analysis & Design of Thermal Systems - Hodge, B.K., 2ndedition, Prentice Hall, 1990.

3. Design of Thermal Systems - Boehm, R.F., John Wiley, 1987.

4. Design of Thermal Systems - Stoecker, W.F., McGraw-Hill

Professional Elective-5

Name of the course	Course Code	Time/ Duration	Credit
Alternative Fuels & Engine Pollution	**MTE-302E**	**4 hrs/week**	**4**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Identify the need of alternate fuels and list out some prospective alternate fuels
CO-2	Categorize, interpret and understand the essential properties of fuels for petrol and diesel engines
CO-3	Infer the storage and dispensing facilities requirements
CO-4	Analyze the implement limitations with regard to performance, emission and materials compatibility

Syllabus Contents:

MODULE-1	Need for alternate fuel : Availability and properties of alternate fuels, general use of alcohols, LPG, hydrogen, ammonia, CNG and LNG, vegetable oils and biogas, merits and demerits of various alternate fuels, introduction to alternate energy sources. Like EV, hybrid, fuel cell and solar cars.
MODULE-2	Alcohols: Properties as engine fuel, alcohols and gasoline blends, performance in SI engine, methanol and gasoline blends, combustion characteristics in CI engines, emission characteristics, DME, DEE properties performance analysis, performance in SI & CI Engines. Natural Gas, LPG, Hydrogen and Biogas: Availability of CNG, properties, modification required to use in engines, performance and emission characteristics of CNG using LPG in SI & CI engines, performance and emission of LPG. Hydrogen; storage and handling, performance and safety aspects
MODULE-3	Technical Background of Diesel/Bio-diesel fuels-Oil feed stocks- Transesterification-Bio-diesel production from Vegetable oils and waste cooking oil-High blend levels of bio-diesel-Testing , Bio diesel-Oxidation stability-Performance in Engines, Properties of bio-fuels and their importance in the context of IC Engines. Vegetable Oils: Various vegetable oils for engines, esterification, performance in engines, performance and emission characteristics, bio diesel and its characteristics
MODULE-4	Electric, Hybrid, Fuel Cell And Solar Cars: Layout of an electric vehicle, advantage and limitations, specifications, system components, electronic control system, high energy and power density batteries, hybrid vehicle, fuel cell vehicles, solar powered vehicles.

Books and References:

1. Alternate Fuels - Dr. S. S. Thipse - Jaico Publications
2. Richard.L.Bechfold, Alternative Fuels Guide BooK, SAE International Warrendale - 1997.
3. Maheswar Dayal, Energy Today & tomorrow, -1 & B Horishr India-1982.
4. Nagpal, Power Plant Engineering, Khanna Publishers, 1991.
5. Alcohols as motor fuels progress in technology, Series No. 19 - SAE Publication USE - 1980.
6. SAE paper nos. 840367, 841333, 841334, 841156, Transactions, SAE, USA

7. Alternative Fuels Guidebook - Bechtold R.

Professional Elective-5

Name of the course	Course Code	Time/ Duration	Credit
Phase Change Phenomena in Fluids	**MTE-303E**	**4 hrs/week**	**4**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Solve for temperature, pressure and enthalpy of Binary mixtures.
CO-2	Analyse pool and flow boiling phenomena to design the heat dissipative cooling equipment.
CO-3	Understand different flow pattern and its instability with bubble behaviour
CO-4	Analyse condensation phenomena in the industrial and commercial equipment.

Syllabus Contents:

MODULE-1	**Fundamentals:** Thermodynamic Equilibrium of Binary and Multi-component mixtures: Fugacity and Fugacity Coefficient of Pure Substance and Mixture, Gibbs Phase Rule. **Binary Mixtures:** Phase Equilibrium Diagrams for Binary Mixtures, Ideal Mixtures, Numerical on phase diagrams of ideal mixtures, Raoult's law of mixture, Zeoptrope and Azoetrope mixture Basic Equations on two phase flow: Mass, Momentum and Energy.
MODULE-2	**Pool Boiling:** Boiling regimes, Dimensional Analysis, Nucleate boiling of ordinary fluids, Numerical on nucleate boiling, Film boiling of ordinary fluids, Passive and Active enhancement techniques in heat transfer enhancement. **Flow boiling:** Boiling regimes in Horizontal and vertical flow, Nucleate boiling in flow, Saturated boiling in flow, Film boiling in flow, Flow boiling for binary mixtures and Augmentation techniques inflow boiling.
MODULE-3	**Flow Patterns and Bubble Dynamics: Flow pattern in Horizontal and vertical tubes:** Bubbly flow, plug flow, Stratified flow, Wavy flow, Slug flow and Annular flow. Two phase flow instability: Taylor and Helmholtz instabilities Homogenous and Heterogeneous Nucleation, Rayleigh-Plesset Equation, Bubble Nucleation site density, Bubble size, Bubble departure, Bubble waiting period, Bubble departure and Simple Numerical.
MODULE-4	**Condensation:** Film wise condensation: Laminar condensation of vapour, Condensation on tube banks and Numerical. Drop wise Condensation: Condensation of steam-Factors effecting.

Books and References:

1. Convective boiling and condensation by John G. Collier and John R. Thome, Third edition, Oxford Science Publication.

2. Boiling heat transfer and Multiphase flow by L.S Tong, Second edition, Taylor and Francis Publication.

3. Hand book of Phase Change in Boiling and Condensation by Sathish G. Kandlikar by Taylor and Francis

Reference Books

1. Fundamentals of Multiphase Flows by Christopher E. Brennen, Cambridge University Press 2005.

Audit Course

Name of the course	Course Code	Time/ Duration	Credit
Research Methodology and IPR	**MID-301A**	**2 hrs/week**	**0**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Understand and formulate research problem.
CO-2	Inculcate research ethics
CO-3	Classify Intellectual Property Right (IPR).
CO-4	Comprehend about Intellectual Property Right utility in general and engineering in particular.

Syllabus Contents:

MODULE-1	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
MODULE-2	Effective literature studies approaches, analysis Plagiarism, Research ethics. Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

MODULE-3	Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.
MODULE-4	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 etc. Traditional knowledge Case Studies, IPR and IITs.

References:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition , "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
5. Mayall , "Industrial Design", McGraw Hill, 1992.
6. Niebel , "Product Design", McGraw Hill, 1974.
7. Asimov , "Introduction to Design", Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
9. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.

Semester-IV

Sessional-7

Name of the course	Course Code	Time/ Duration	Credit
Thesis Report Final	**MTE-401S**	**8 hrs/week**	**4**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Understand that how to write thesis with good readability
CO-2	Learn to write section wise.
CO-3	Understand the skills needed while writing a thesis
CO-4	Ensure the quality of thesis report

Syllabus Contents:

Module-1	Planning and Preparation, Clarifying contributions of other authors, summarizing your findings, paraphrasing and plagiarism, sections of your thesis.
Module-2	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check. key skills are needed when writing a thesis, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a review of the literature.
Module-3	Skills are needed when writing about the methods and results, skills are needed when writing the discussion, skills are needed when writing the conclusions.
Module-4	Useful phrases, how to ensure thesis is as good as it could possibly be the first-time thesis writing.

Sessional-8

Name of the course	Course Code	Time/ Duration	Credit
Thesis Seminar Final (Presentation and Viva Voce)	**MTE-402S**	**8 hrs/week**	**4**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Synthesize knowledge and skills previously gained and applied to an in-depth study and execution of new technical problem.
CO-2	Identify from different methodologies, methods and forms of analysis to produce a suitable research design, and justify their design.
CO-3	Demonstrate the findings of their technical solution in a written report.
CO-4	Present the work in International/ National conference or reputed journals.

Syllabus Contents:

The dissertation / project topic should be selected / chosen to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study.

A. The dissertation should have the following-

vi) Relevance to social needs of society
vii) Relevance to value addition to existing facilities in the institute
viii) Relevance to industry need
ix) Problems of national importance
x) Research and development in various domain

B. The student should complete the following:

vi) Literature survey Problem Definition
vii) Motivation for study and Objectives
viii) Preliminary design / feasibility / modular approaches
ix) Implementation and Verification
x) Report and presentation

Sessional-9

Name of the course	Course Code	Time/ Duration	Credit
Workshop and Seminars-II	**MTE-403S**	**2 hrs/week**	**2**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Follow discussions, oral arguments, and presentations, noting main points or evidence and tracking threads through different comments
CO-2	Prepare appropriately to participate effectively and offer substantive replies to others' arguments, comments, and questions, while remaining sensitive to the original speaker and the classroom audience
CO-3	Speak and debate with an appreciation for complex social and technical sensibilities
CO-4	Offer compelling, articulate oral arguments, showing an understanding of the unique demands of oral presentation as opposed to writing

Syllabus Contents:

1. Participate effectively in discussion of workshops and seminars [at least 02(two)].
2. Follow discussions, oral arguments, and presentations, noting main points or evidence and tracking threads through different comments and submit a comprehensive report to the department.
3. Demonstration of the ability to speak and defend (to be presented in the presentation seminar organized by the department).
4. Understanding of the unique demands of oral presentation as opposed to writing.(presentation skills will be evaluated)
5. Those who are unable to attend seminar / conferences/ workshops within the semester period needs to pass at least 01(one) NPTEL / MOOCs course of at least 04(four) weeks duration which should be relevant to project and thesis topic. Grade/ percentage of marks obtained in the NPTEL / MOOCs course examination will be proportionately taken into account for final evaluation of sessional -9.

Open Elective

Name of the course	Course Code	Time/ Duration	Credit
Medical Image Processing	**MDS-401O**	**4hrs/week**	**4**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Gain knowledge about basic medical imaging modalities (Understanding)
CO-2	Able to evaluate and validate medical image data (Evaluation)
CO-3	Learn to segment and classify various medical image data using various machine learning and deep learning techniques (Comprehension)
CO-4	Acquaintances with some recent advances through Case studies (Evaluation)

Syllabus Contents:

MODULE-1	Introduction to medical imaging modalities and image analysis software, Introduction to Medical Image Analysis, X Ray and CT Imaging, Magnetic Resonance Imaging, Ultrasound Imaging, Optical Microscopy and Molecular Imaging
MODULE-2	Feature extraction, segmentation, systematic evaluation and validation on datasets, Texture in Medical Images, Region Growing and Clustering, Random Walks for Segmentation, Active Contours for Segmentation
MODULE-3	Machine learning based approaches for segmentation and classification, Systematic Evaluation and Validation, Decision Trees for Segmentation and Classification, Random Forests for Segmentation and Classification, Neural Networks for Segmentation and Classification, Deep Learning for Medical Image Analysis
MODULE-4	Case studies on some recent advances in analysis of retinal, CT, MRI, ultrasound and histology images, Retinal Vessel Segmentation, Vessel Segmentation in Computed Tomography Scan of Lungs, Tissue Characterization in Ultrasound

Books and References:

1. swayam.gov.in
2. Guide to Medical Image Analysis: Methods and Algorithms, Klaus D. Toennies, Print ISBN: 978-1-4471-2750-5
3. Advancement of Machine Intelligence in Interactive Medical Image Analysis, Om Prakash Verma, Sudipta Roy, Subhash Chandra Pandey, Mamta Mittal, Print ISBN: 978-981-15-1099-1

Open Elective

Name of the course	Course Code	Time/ Duration	Credit
Data Warehousing	**MDS-402O**	**4hrs/week**	**4**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Evaluate of different sequential pattern algorithms

CO-2	Realize the technique to extract patterns from time series data and its application in real world.
CO-3	Apply the Graph mining algorithms to Web mining
CO-4	Identify the computing framework for Big Data

Syllabus Contents:

MODULE-1	Introduction to Data Warehousing; Data Mining: Mining frequent patterns, association and correlations; Sequential Pattern Mining concepts, primitives, scalable methods; Classification and prediction; Cluster Analysis – Types of Data in Cluster Analysis, Partitioning methods, Hierarchical Methods; Transactional Patterns and other temporal based frequent patterns.
MODULE-2	Mining Time series Data, Periodicity Analysis for time related sequence data, Trend analysis, Similarity search in Time-series analysis
MODULE-3	Mining Data Streams, Methodologies for stream data processing and stream data systems, Frequent pattern mining in stream data, Sequential Pattern Mining in Data Streams, Classification of dynamic data streams, Class Imbalance Problem; Graph Mining; Social Network Analysis
MODULE-4	Web Mining, Mining the web page layout structure, mining web link structure, mining multimedia data on the web, Automatic classification of web documents and web usage mining; Distributed Data Mining. Recent trends in Distributed Warehousing and Data Mining, Class Imbalance Problem; Graph Mining; Social Network Analysis techniques.

Books and References:

1. Jiawei Han and M Kamber, Data Mining Concepts and Techniques, Second Edition, Elsevier Publication, 2011.

2. Vipin Kumar, Introduction to Data Mining - Pang-Ning Tan, Michael Steinbach, Addison Wesley, 2006. 3. G Dong and J Pei, Sequence Data Mining, Springer, 2007.

Open Elective

Name of the course	Course Code	Time/ Duration	Credit
Data Storage Technologies	**MVE-401O**	**4hrs/week**	**4**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Understand and design random access memory and subsystems.
CO-2	Identify read only memory, fault models, modes and mechanisms in semiconductor memories and their testing procedures.
CO-3	Demonstrate the state-of-the-art memory chip design.

CO-4	Understanding of memory hybrids.

Syllabus Contents:

MODULE-1	Random Access Memory Technologies: Static Random Access Memories (SRAMs), SRAM Cell Structures, MOS SRAM Architecture, MOS SRAM Cell and Peripheral Circuit, Bipolar SRAM, Advanced SRAM Architectures, Application Specific SRAMs. DRAMs, MOS DRAM Cell, BiC MOSDRAM, Error Failures in DRAM, Advanced DRAM Design and Architecture, Application Specific DRAMs.SRAM and DRAM Memory controllers.
MODULE-2	Non-Volatile Memories: Masked ROMs, PROMs, Bipolar & CMOS PROM, EEPROMs, Floating Gate, EPROM Cell, OTP EPROM, EEPROMs, Non-volatile SRAM, Flash Memories. Semiconductor Memory Reliability and Radiation Effects: General Reliability Issues, RAM Failure, Modes and Mechanism, Nonvolatile Memory, Radiation Effects, SEP, Radiation Hardening Techniques. Process and Design Issues.
MODULE-3	Advanced Memory Technologies and High-density Memory Packing Technologies: Ferroelectric Random Access Memories (FRAMs), Gallium Arsenide (GaAs) FRAMs, Analog Memories, Magneto Resistive Random Access Memories (MRAMs).
MODULE-4	Memory Hybrids (2D & 3D), Memory Stacks, Memory Testing and Reliability Issues, Memory Cards, High Density Memory Packaging.

Books and References:

- Ashok K Sharma, "Advanced Semiconductor Memories: Architectures, Designs and Applications", Wiley Interscience.
- Kiyoo Itoh, "VLSI memory chip design", Springer International Edition
- Ashok K Sharma," Semiconductor Memories: Technology, Testing and Reliability , PHI.

Open Elective

Name of the course	Course Code	Time/ Duration	Credit
Cyber Security and Data Encryption	**MVE-402O**	**4hrs/week**	**4**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Identify and utilize different forms of cryptography techniques.
CO-2	Compare number theory algorithms.
CO-3	Distinguish between private and public key cryptography.
CO-4	Demonstrate Authentication- IP and Web Security Encapsulating Security Payload.
CO-5	Understand System Security- Intruders Firewalls, Firewall Design Principles, Trusted Systems.

Syllabus Contents:

MODULE-1	Security- Need, security services, Attacks, OSI Security Architecture, one time passwords, Model for Network security, Classical Encryption Techniques like substitution ciphers, Transposition ciphers, Cryptanalysis of Classical Encryption Techniques.
MODULE-2	Number Theory- Introduction, Fermat's and Euler's Theorem, The Chinese Remainder Theorem, Euclidean Algorithm, Extended Euclidean Algorithm, and Modular Arithmetic.
MODULE-3	Private-Key (Symmetric) Cryptography- Block Ciphers, Stream Ciphers, RC4 Stream cipher, Data Encryption Standard (DES), Advanced Encryption Standard (AES), Triple DES, RC5, IDEA, Linear and Differential Cryptanalysis. Public-Key (Asymmetric) Cryptography - RSA, Key Distribution and Management, Diffie-Hellman Key Exchange, Elliptic Curve Cryptography, Message Authentication Code, hash functions, message digest algorithms:MD4 MD5, Secure Hash algorithm, RIPEMD-160, HMAC.
MODULE-4	Authentication- IP and Web Security Digital Signatures, Digital Signature Standards, Authentication Protocols, Kerberos, IP security Architecture, Encapsulating Security Payload, Key Management, Web Security Considerations, Secure Socket Layer and Transport Layer Security, Secure Electronic Transaction. System Security- Intruders, Intrusion Detection, Password Management, Worms, viruses, Trojans, Virus Countermeasures, Firewalls, Firewall Design Principles, Trusted Systems.

Books and References:

- William Stallings, "Cryptography and Network Security, Principles and Practices", Pearson Education, 3rd Edition.
- Charlie Kaufman, Radia Perlman and Mike Speciner, "Network Security, Private Communication in a Public World", Prentice Hall, 2nd Edition
- Christopher M. King, ErtemOsmanoglu, Curtis Dalton, "Security Architecture, Design Deployment and Operations", RSA Pres,
- Stephen Northcutt, LenyZeltser, Scott Winters, Karen Kent, and Ronald W. Ritchey, "Inside Network Perimeter Security", Pearson Education, 2nd Edition
- Richard Bejtlich, "The Practice of Network Security Monitoring: Understanding Incident Detection and Response", William Pollock Publisher, 2013.

Foundation Course

Name of the course	Course Code	Time/ Duration	Credit

English for research paper writing	MID-401F	2 hrs/week	0

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Identify scope to improve writing skills and level of readability.
CO-2	Demonstrate technical paper writing skills.
CO-3	Develop the skills to write a good quality of paper.
CO-4	Present the Literature review, Methods, Results, Discussion, Conclusions and Final Check in result oriented manner.

Syllabus Contents:

MODULE-1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.
MODULE-2	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction
MODULE-3	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,
MODULE-4	Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.

References:

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

Foundation Course

Name of the course	Course Code	Time/ Duration	Credit
Disaster management	**MID-402F**	**2 hrs/week**	**0**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO-2	Understand Repercussions Of Disasters And Hazards.
CO-3	Illustrate natural and man made disasters.
CO-4	Classify disaster prone areas in India.
CO-5	Analysis of disaster risk assessment and reduction mechanisms.

Syllabus Contents:

MODULE-1	Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.
MODULE-2	Repercussions Of Disasters And Hazards: Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.
MODULE-3	Disaster Prone Areas In India Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics. Disaster Preparedness And Management Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And CommModuley Preparedness.
MODULE-4	Risk Assessment Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.Disaster Mitigation Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

References:

- R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
- Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
- Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.

Foundation Course

Name of the course	Course Code	Time/ Duration	Credit
Sanskrit for technical knowledge	**MID-403F**	**2 hrs/week**	**0**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Develop a working knowledge in illustrious Sanskrit, the scientific language in the world
CO-2	Learn Sanskrit to improve brain functioning
CO-3	Develop the logic in mathematics, science & other subjects enhancing the memory power
CO-4	Explore the technical knowledge from ancient literature.

Syllabus Contents:

MODULE-1	Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences.
MODULE-2	Order, Introduction of roots.
MODULE-3	Technical information about Sanskrit Literature.
MODULE-4	Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics.

References:

- "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
- "Teach Yourself Sanskrit" Prathama Deeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, NewDelhi Publication
- "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

Foundation Course

Name of the course	Course Code	Time/ Duration	Credit
Value education	**MID-404F**	**2 hrs/week**	**0**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Understand value of education and self- development.
CO-2	Imbibe good values in students.
CO-3	Inculcate about the importance of character.
CO-4	Demonstratemind training, Self-control, Honesty, Studying effectively.

Syllabus Contents:

MODULE-1	Values and self-development –Social values and individual, attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgements
MODULE-2	Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Moduley. Patriotism. Love for nature ,Discipline
MODULE-3	Personality and Behavior Development – Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature
MODULE-4	Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

References:

- Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

Foundation Course

Name of the course	Course Code	Time/ Duration	Credit
Constitution of India	**MID-405F**	**2 hrs/week**	**0**

At the end of the course, students will demonstrate the ability to-

	Course Outcome
CO-1	Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.

CO-2	Understand the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
CO-3	Understand 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.
CO-4	Demonstratethe Role and Functioning ofElection Commission,.

Syllabus Contents:

MODULE-1	History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working)
MODULE-2	Philosophy of the Indian Constitution: Preamble, Salient Features. Contours of Constitutional Rights & Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.
MODULE-3	Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: ZilaPachayat. Elected officials and their roles, CEO ZilaPachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.
MODULE-4	Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

References:

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

Foundation Course

Name of the course	Course Code	Time/ Duration	Credit
Pedagogy studies	**MID-406F**	**2 hrs/week**	**0**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Understand parameters and terminology of pedagogy.
CO-2	Compare pedagogical practices in developing countries.
CO-3	Measure effectiveness of pedagogical practices.
CO-4	Assess Professional development by alignment with classroom practices and follow-up support and Peer support.
CO-5	Identify Research gaps and future directions, Research design, Contexts, Pedagogy,etc.

Syllabus Contents:

MODULE-1	Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology. Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions. Overview of methodology and Searching.
MODULE-2	Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.
MODULE-3	Evidence on the effectiveness of pedagogical practices. Methodology for the in depth stage: quality assessment of included, studies. How can teacher education (curriculum and practicum) and the school, curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical.practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.
MODULE-4	Professional development: alignment with classroom practices and follow-up support Peer support. Support from the head teacher and the commModuley. Curriculum and assessment. Barriers to learning: limited resources and large class sizes.Research gaps and future directions, Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.

References:

- Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
- Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
- Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
- Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
- Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
- Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
- www.pratham.org/images/resource%20working%20paper%202.pdf.

Foundation Course

Name of the course	Course Code	Time/ Duration	Credit
Stress management by Yoga	**MID-407F**	**2 hrs/week**	**0**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Understand the role of yoga in developing overall health of body and mind.
CO-2	Understand the importance of Yoga in Overcoming stress.
CO-3	Experiment with various asanas and Pranayams.
CO-4	Implement breathing techniques.

Syllabus Contents:

MODULE-1	Definitions of Eight parts of yog. (Ashtanga)

MODULE-2	Yam and Niyam. Do`s and Don't's in life. I) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan.
MODULE-3	Asan and Pranayam- Various yog poses and their benefits for mind & body.
MODULE-4	Regularization of breathing techniques and its effects-Types of pranayam

References:

- 'Yogic Asanas for Group Tarining-Part-I" : Janardan Swami Yogabhyasi Mandal, Nagpur
- "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata

Foundation Course

Name of the course	Course Code	Time/ Duration	Credit
Personality development through life enlightenment skills	**MID-408F**	**2 hrs/week**	**0**

Course Outcomes:

At the end of the course students will be able to-	
CO-1	Understand the skill to achieve the highest goal happily.
CO-2	Develop the skills of a person with stable mind, pleasing personality and determination.
CO-3	Inculcate wisdom in them.
CO-4	Understand basic knowledge of Shrimad BhagwadGeeta.

Syllabus Contents:

MODULE-1	Neetisatakam-Holistic development of personality Verses- 19,20,21,22 (wisdom), Verses-29,31,32 (pride & heroism) Verses- 26,28,63,65 (virtue), Verses- 52,53,59 (dont's), Verses-71,73,75,78 (do's).
MODULE-2	Approach to day to day work and duties. Shrimad BhagwadGeeta : Chapter 2-Verses 41, 47,48, Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35, Chapter 18-Verses 45, 46, 48.
MODULE-3	Statements of basic knowledge. Shrimad BhagwadGeeta: Chapter2-Verses 56, 62, 68, Chapter 12 -Verses 13, 14, 15, 16,17, 18.
MODULE-4	Personality of Role model. Shrimad BhagwadGeeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42, Chapter 4-Verses 18, 38,39, Chapter18 – Verses 37,38,63.

References:

- "Srimad Bhagavad Gita" by Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata
- Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.