ASSAM SCIENCE AND TECHNOLOGY UNIVERSITY

Guwahati

Course Structure and Syllabus

(From Academic Session 2018-19 onwards)

M. Tech in

THERMAL AND FLUID ENGINEERING

2^{nd} Semester

ASSAM SCIENCE AND TECHNOLOGY UNIVERSITY

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Course Structure and Syllabus

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M. Tech in

THERMAL AND FLUID ENGINEERING

2nd Semester

Sl. No.	Sub-Code	Subject	Hours per Week			Credits
			L	T	P	C
Theory						
1	ME182T201	Convective Heat Transfer Analysis	4	0	0	4
2	ME182T202	Experimental Methods In Thermal Engineering	4	0	0	4
3	ME182T203	Computational Fluid Dynamics	3	0	0	3
4	ME182T204E2*	Elective-II	3	0	0	3
5	ME182T205E3*	Elective-III	3	0	0	3
Practical						
1	ME182T213	Computational Fluid Dynamics Laboratory	0	0	4	2
2	ME182T226	Seminar-II	0	0	0	1
		Total	17	0	4	**20**
Total Contact Hours per week : 21						
Total Credit : 20						

List of Elective–II Subjects

Sl. No.	Sub-Code	Subject
1	ME182T204E21	Modern Trends in Refrigeration and Air Conditioning
2	ME182T204E22	Advanced Gas Turbines and Jet Propulsions
3	ME182T204E23	Microfluidics
4	ME182T204E24	Compressible Flow
5	ME182T204E2*	Any other subject offered from time to time with the approval of the University

List of Elective–III Subjects

Sl. No.	Sub-Code	Subject
1	ME182T205E31	Advanced Power Plant Engineering
2	ME182T205E32	Principles of Combustion and Emissions
3	ME182T205E33	Solar Energy
4	ME182T205E34	Batteries and Fuel Cells
5	ME182T205E3*	Any other subject offered from time to time with the approval of the University

Detailed Syllabus

Course Code	Course Title	Hours per week L-T-P	Credit C
ME182T201	**Convective Heat Transfer Analysis**	**4-0-0**	**4**

MODULE 1:

Introduction to convection, Order of magnitude analysis, Reynolds analogy.

MODULE 2:

Convective heat transfer in external flows: Derivation of hydrodynamic and thermal boundary layer equations.

MODULE 3:

Convection in internal flows: Concept of developing and fully developed flows, Thermally developing flows, Steady forced convection in Hagen Poiseuille flow, Plane Poiseuille flow and Couette flow and analytical evaluation of Nusselt numbers in limiting cases.

MODULE 4:

Free convection: Free convection boundary layer equations: order of magnitude analysis.

MODULE 5:

Concept of boiling heat transfer and regimes in pool boiling, Condensation: Nusselt film condensation theory, dropwise condensation and condensation inside tubes.

Text and Reference Books:

1. Louis C. Burmeister, Convective Heat Transfer
2. Bejan, Convective Heat Transfer
3. T. Cebeci & P. Bradshaw, Physical and Computational Aspects of Convective Heat Transfer
4. S. Kakac, Y. Yener & A. Pramuanjaroenkij,Convective Heat Transfer
5. Kays & Crawford, Heat Transfer

Course Code	Course Title	Hours per week L-T-P	Credit C
ME182T202	Experimental Methods In Thermal Engineering	4-0-0	4

MODULE 1:

Introduction to measurement: Importance of measurement and experimentation, calibration, uncertainity analysis, error propagation, Gaussian or Normal Distribution, confidence level, regression analysis, correlation coefficient, Chi-Square test, zeroth- first and second- order systems.

MODULE 2:

Pressure Measurement: Manometers, bourdon tube pressure gage, diaphragm gage, bellow gage, McLeod gage, Pirani gage and ionization gage.

MODULE 3:

Flow measurement: Positive displacement flow meters, venture, orifice, impact tube flow nozzle, sonic nozzle, rotameter, pitot static tube, hot wire anemometer, laser Doppler anemometer, flow visualization techniques – shadowgraph. Shlieren and interferometer.

MODULE 4:

Temperature measurement: Hg-in-glass thermometer, RTD, thermistor, thermocouple, thermopile, liquid-crystal thermography, optical pyrometer.

MODULE 5:

Data acquisition and processing: Signal conditioning, data transmission, storage, A to D and D to A conversion.

Text and Reference Books:

1. T. G. Beckwith, J. H. Lienhard V, R. D. Marngoni, Mechanical Instruments
2. E. O. Doebelin, Measurement systems, Application and Design
3. J. P. Holman, Experimental Methods for Engineers

Course Code	Course Title	Hours per week L-T-P	Credit C
ME182T203	**Computational Fluid Dynamics**	**3-0-0**	**3**

MODULE 1:

A brief overview of the basic conservation equations for fluid flow and heat transfer, classification of partial differential equations and pertinent physical behaviour, parabolic elliptic and hyperbolic equations, role of characteristics, Computational economy. Numerical stability, Selection of numerical methods, validation of numerical results: Numerical error and accuracy – Round off error, accuracy of numerical results – Iterative convergence – Condition for convergence, Rate of convergence, under-relaxation and over relaxation, Termination of iteration, Traditional Matrix algorithm.

MODULE 2:

Finite Difference method: Discretization – Converting derivatives to discrete Algebraic Expressions, Taylor's series approach, polynomial fitting approach, Discretization error.

MODULE 3:

One dimensional, two dimensional and three dimensional transient heat conduction problems in Cartesian and cylindrical co-ordinates- Explicit, Implicit, Crank Nicholson and ADI methods-stability of each system.

MODULE 4:

The finite volume method: Discretization of diffusion problems: one dimensional steady diffusion problems, specification of interface diffusivity, source-term linearization, Discretization of transient one-dimensional diffusion problems.

Text & Reference Books:

1. John D Anderson Jr, Computational Fluid Dynamics, McGraw Hill
2. Hoffman Klaus Vol-1 & 2 Computational Fluid Dynamics
3. D.A.Anderson, J.C.Tannehill and R.H.Fletcher, Computational Fluid Flow and Heat Transfer
4. S.V.Patankar Hemisphere, Numerical Fluid Flow & Heat transfer
5. H.K Versteeg and W Malalasekera, An Introduction to Computational Fluid Dynamics

Course Code	Course Title	Hours per week L-T-P	Credit C
ME182T204E21	**Modern Trends in Refrigeration and Air-Conditioning**	**3-0-0**	**3**

MODULE 1:

Introduction to modern refrigeration and air-conditioning practices, Industrial and Commercial applications.

MODULE 2:

Refrigeration Systems: Gas-Cycle systems, Simple cycles – Carnot and Bell-Coleman, Regenerative & reduced ambient system, Air-craft refrigerating system – simple boot-strap, reduced ambient. Actual cycles, ramming, Advantages and disadvantages of DART.

MODULE 3:

Vapour-Compression systems, Analysis of simple cycles, representation of TS, Ph plans, methods of improving COP, Deviations of actual cycles from theoretical cycles, Compound compression with liquid flash cooler, flash inter-cooler multiple systems – COP, power required, Ewing diagram, Multistage multi evaporator and Cascade systems.

MODULE 4:

Psychrometry, simple psychrometric processes, use of psychrometric chart, Comfort and industrial air conditioning, Air flitration, Principles of ventilation, Physiological factors, Comfort index, Load Analysis and Calculations: Design conditions, Load classifications, Cooling and Heating load analysis.

Text & Reference Books:

1. Arora C.P, Refrigeration and Air conditioning
2. R.C.Arora, Refrigeration and Air conditioning
3. Ananthanarayanan, Basic Refrigeration and Air conditioning
4. W.B.Gosney, Principles of Refrigeration
5. Stoecker, Refrigeration and Air conditioning
6. Manohar Prasad, Refrigeration and Air conditioning

Course Code	Course Title	Hours per week L-T-P	Credit C
ME182T204E22	**Advanced Gas Turbines and Jet Propulsions**	**3-0-0**	**3**

MODULE 1:

A review of thermodynamic cycles of gas turbines, Evaluation of various types of turbines and compressors.

MODULE 2:

Axial flow turbines; blade diagrams and design of blading, performance characteristics. Centrifugal and axial flow compressors, blowers and fans, Theory and design of impellers and blading. Matching of turbines and compressors.

MODULE 3:

Types of gas turbine fuels, Design of combustion chamber, Burner design parameters. Combustion stability, length scaling, total pressure ratio, effect of combustion chamber design and exhaust on performance, Basic principles and methods of heat recovery.

MODULE 4:

Thrust equation, classification and comparison of ram jets, turbojets, pulse jets and rockets. Performance of turbo-prop, turbo-jet and turbo-fan engines, Augmentation of thrust, Parametric cycle analysis of Ideal engines.

Text & Reference books:

1. HIH Saravanamutto, H. Cohen, GFC Rogers, Gas Turbine Theory
2. V. Ganesan, Gas Turbine.
3. J.D. Mattingly, Elements of gas turbine propulsion

Course Code	Course Title	Hours per week L-T-P	Credit C
ME182T204E23	**Microfluidics**	**3-0-0**	**3**

MODULE 1:

Introduction: Fundamentals of kinetic theory-molecular models, micro and macroscopic properties, binary collisions, distribution functions, Boltzmann equation and Maxwellian distribution functions, continuum hypothesis and deviations from the same, scaling laws for micro-domains.

MODULE 2:

Microscale gas flows: Wall slip effects and accommodation coefficients, flow and heat transfer analysis of microscale Couette flows, Pressure driven gas micro-flows with wall slip effects, heat transfer in micro-Poiseuille flows, effects of compressibility, introductory concepts on gas flows in transitional and free molecular regimes, some representative applications of micro-scale gas flows in accelerometers, micro-propulsion and micro-nozzles.

MODULE 3:

Microscale liquid flows: Pressure driven liquid microflow, apparent slip effects, physics of near-wall microscale liquid flows, capillary flows, electro-kinetically driven liquid micro flows and Electric Double Layer (EDL) effects, concepts of electroosmosis, electrophoresis and dilectro-phoresis, analysis of hydro-dynamically and thermally fully developed electro osmotic flows, ac electro-osmosis.

MODULE 4:

An introduction to fluid dynamics over nano scales (nanofluidics), concepts of nano-fluids and their augmented transport characteristics.

Text & Reference Books:

1. Terrence Conlisk, Essentials Of Micro And Nanofluidics.
2. Dongqing Li, (Editor), Encyclopedia Of Microfluidics And Nanofluidics.
3. S. Chakraborty (Editor), Microfluidics And Microscale Transport Processes
4. S. Mitra And S. Chakraborty (Editors), Handbook Of Microfluidics And Nanofluidics.

Course Code	Course Title	Hours per week L-T-P	Credit C
ME182T204E24	**Compressible Flow**	**3-0-0**	**3**

MODULE 1:

Fundamental Aspects of Compressible flow: Introduction, isentropic flow in a streamtube, speed of sound, Mach waves.

MODULE 2:

One dimensional isentropic flow: Governing Equations, stagnation conditions, critical conditions, maximum discharge velocity, isentropic relations.

MODULE 3:

Normal shock waves: Shock waves, stationary normal shock waves, normal shock wave relations in terms of mach number.

MODULE 4:

Oblique Shock waves: Oblique shock wave relations, reflections of oblique shock waves, interactions of oblique shock waves, conical shock waves.

MODULE 5:

Variable area flow: Equations for variable area flow, operating characteristics of nozzles, convergent-divergent supersonic diffusers.

MODULE 6:

Adiabatic flow in a duct with friction: Flow in a constant area duct, friction factor variations, the Fano line; Flow with Heat addition or removal, One dimensional flow in a constant area duct neglecting viscosity, variable area flow with heat addition, one dimensional constant area flow with both heat exchanger and friction.

Text & Reference Books:

1. H.Shapiro-The Dynamics and Thermodynamics of Compressible Fluid flow
2. S.M.Yahya-Fundamentals of Compressible Flow
3. Osthuizen and Carscallen-Compressible Fluid Flow

Course Code	Course Title	Hours per week L-T-P	Credit C
ME182T205E31	**Advanced Power Plant Engineering**	**3-0-0**	**3**

MODULE 1:

Introduction: Choice of power generation, Load and Load duration curves, Load factor, Diversity factor, Load deviation curve, Load management, Number and size of generating unit, Cost of electrical energy, Tariff-Power factor improvement.

MODULE 2:

Thermal Power Station: Site selection of steam power plant, general layout, instrumentation and control, Steam generation, Boiler, superheater, reheater, air preheater, economiser, condenser, combustion chamber, fuel handling, coal firing furnace, fluidized bed combustion, cooling tower, cooling pond.

MODULE 3:

Gas Turbine Power Plant: Types, open and close cycle gas turbines, components of plant, plant layout, combined cycle power plant.

MODULE 4:

Hydropower Plant: Classification, components, types, governing, Installation, operation, maintenance, Turbines- characteristics and their selection, plant layout and design.

MODULE 5:

Nuclear Power Plant: Basic principles, Elements of nuclear power plant, Nuclear reactor and fuels, Hazards due to Nuclear power plants.

MODULE 6:

Diesel-electric Power Plant: Working principle, plant layout, engine performance, Installation and maintenance, advantages and disadvantages, starting and stopping, efficiency and heat balance.

Text and Reference Books:

1. P.K. Nag-Power Plant Engineering
2. El Wakil- Power Plant Engineering
3. A.J. Wood, B.F.Wollenberg-Power Generation, Operation and Control
4. Arora and Domkundwar- A course in Power Plant Engineering

Course Code	Course Title	Hours per week L-T-P	Credit C
ME182T205E32	**Principles of Combustion and Emissions**	**3-0-0**	**3**

MODULE 1:

Introductory concepts, Thermodynamics of reacting systems: conservation of mass and energy in a chemical reaction, adiabatic flame temperature, second law aspects of chemical reactions.

MODULE 2:

Pre-mixed systems: Theories of premixed laminar and turbulent flames; concepts of ignition, flame stabilization, extinction and quenching, Methods of measuring flame velocity; Flame quenching.

MODULE 3:

Non-Pre-mixed systems; Burke-Schumann's theory of laminar diffusion flames; Droplet burning; Laminar diffusion flames.

MODULE 4:

Theories of gaseous diffusion flames; droplet and spray combustion: theories of atomization, spray combustion models, spray combustion characteristics and design of burners; mechanism and kinetics of coal combustion; fluidized bed combustion.

MODULE 5:

Emission from combustion; constituents and types of emission, mechanisms of hydrocarbon and particulate emissions, theories of soot and NOx formation, Control of emissions.

Text & Reference Books:

1. Turns: An Introduction to Combustion: Concepts And Applications
2. K.K. Kuo, Principles of Combustion

Course Code	Course Title	Hours per week L-T-P	Credit C
ME182T205E33	**Solar Energy**	**3-0-0**	**3**

MODULE 1:

Solar Energy Technology, Current alternate energy sources-thermodynamic view point and conversion methods, Components of solar energy systems, collector performance, Radiation and meteorological data processing, long term conversion factors.

MODULE 2:

System configurations and system performance prediction, Simulations, design methods, System design and optimisation, Solar thermal systems applications to power generation, heating and cooling, Solar passive devices: solar stills, ponds, greenhouse, dryers, Trombe wall, overhangs and winged walls, Economics of solar energy system.

MODULE 3:

Source of radiation – solar constant – solar charts – Measurement of diffuse, global and direct solar radiation: pyrheliometer, pyranometer, pyregeometer, net pyradiometer-sunshine recorder.

MODULE 4:

Solar Non-Concentrating Collectors – Design considerations – Classification – air, liquid heating collectors – Derivation of efficiency and testing of flat plate collectors, Analysis of concentric tube collector – Solar green house.

Text & Reference Books:

1. S.P. Sukhamte, J.K. Nayak, Solar Energy: Principles of Thermal Collection and Storage.
2. H. P. Garg, J. Prakash, Solar Energy: Fundamentals and Applications
3. F. Kreith And J.F. Kreider, Principles of Solar Engineering
4. J.A. Duffie And W.A. Beckman, Solar Engineering of Thermal Processes

Course Code	Course Title	Hours per week L-T-P	Credit C
ME182T205E34	**Batteries and Fuel Cells**	**3-0-0**	**3**

MODULE 1:

Energy Resources, Energy Crisis, Need for Energy storage: Fuel cell and Battery.

MODULE 2:

Battery- Introduction, Types of Batteries and their operational principle.

MODULE 3:

Fuel Cells – principle – working – thermodynamics and kinetics of fuel cell process performance evaluation of fuel cell – comparison on battery vs fuel cell.

MODULE 4:

Types of fuel cells – AFC, PAFC, SOFC, MCFC, DMFC, PEMFC – relative merits and demerits.

MODULE 5:

Application of fuel cell and economics: Fuel cell usage for domestic power systems, large scale power generation, Automobile, Space.

MODULE 6:

Economic and environmental analysis on usage of Hydrogen and Fuel cell, Future trends in fuel cells.

Text & Reference Books:

1. B. Hart and G.J. Womack, Fuel Cells: Theory and Application
2. Viswanathan and M Aulice Scibioh, Fuel Cells – Principles and Applications.
3. L. Rebecca and Busby, Hydrogen and Fuel Cells: A Comprehensive Guide.
4. Bent Sorensen (Sorensen), Hydrogen And Fuel Cells: Emerging Technologies and Applications

Course Code	Course Title	Hours per week L-T-P	Credit C
ME182T213	**Computational Fluid Dynamics Laboratory**	**0-0-4**	**2**

ANSYS Laboratory

Students have to study and learn basic tool of ANSYS Fluent software to solve and analyze various fluid flow and heat transfer problems.

Course Code	Course Title	Hours per week L-T-P	Credit C
ME182T226	**SEMINAR-II**	**0-0-0**	**1**

Individual students are required to choose a topic of their interest from thermal and fluid engineering related topics preferably from outside the M.Tech syllabus and give a seminar on that topic about 30 minutes. A committee consisting of at least two/three faculty members shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his/her seminar topic. One copy shall be returned to the student after duly certifying it by the Chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

ESE: 100 Marks

Evaluation shall be based on the following pattern:
Report = 40 marks
Concept/knowledge in the topic = 30 marks
Presentation = 30 marks
Total Marks = 100 marks

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