ماجستير تقنيات هندسة الحراريات

تهدف دراسة الماجستير الى تهيئة كوادر عليا متخصصة في تقنيات هندسة الحراريات، و يؤهل الخريج ليكون قادرا على:

1. **أجراء الدراسات و البحوث ضمن تخصصه**
2. **تقديم الاستشارات العلمية و العملية و حل المعضلات في حقل العمل ضمن اختصاصه.**
3. **تصميم منظومات التكييف و التثليج و محطات الطاقة الحراريه و تطوير المنظومات المختلفة ضمن اختصاصه بما يتلاءم مع ظروف العمل.**

تسمية الشهادة:

1. **شهادة الماجستير في تقنيات هندسة الحراريات**

المدخلات:

قبول الخريجين من حملة شهادة البكالوريوس باختصاص حراريات:

1. **هندسة تقنيات التبريد و التكييف.**
2. **هندسة المكائن و المعدات.**
3. **الهندسة الميكانيكية.**
4. **دبلوم عالي تبريد**
5. **هندسة تقنيات السيارات**

ماجستير تقنيات هندسة الحراريات

الفصل الاول

ت	المادة	نظري	عملي	وحدات
1	انتقال حرارة متقدم	2	2	3
2	ميكانيك موائع متقدم	2	2	3
3	ديناميك حراري متقدم	2		2
4	تصميم اجهزه الاختبار والقياسات وتحليل البيانات	2	2	3
5	رياضيات تطبيقيه متقدمه	2		2
6	لغه انكليزيه	2		2
	المجموع	12	6	15

الفصل الثاني

ت	المادة	نظري	عملي	وحدات
1	تصميم مبادلات حراريه متقدم	2	2	3
2	ديناميك الموائع الحسابي(CFD)	2	2	3
3	تحليل الاكسيرجي للنظم الحرارية	2		2
4	ماده اختياريه#	2		2
5	ماده اختياريه#	2		2
6	لغه انكليزيه	2		2
	المجموع	12	4	14

المواد الاختياريه

ت	المادة	نظري	عملي	وحدات
1-1	تصميم وتحسين اداء أنظمةِ تكييف الهواء	2		2
2-1	وسائط التبريد المختلطه وتطبيقات الحراره المنخفضه	2		2
3-1	تصميم وتحسين اداء أنظمةِ التبريدِ	2		2
1-2	هندسة محطات قدره متقدم	2		2
2-2	مكائن هيدروليكيه وتوربينيه	2		2
3-2	ديناميكية الاحتراق والبيئه	2		2

 # المواد الاختياريه اما من المجموعه-1 او من المجموعه-2

Master of Science Courses-Thermal Power
First Course - General

	Subject	Theoretical	Practical	Units
1	Advanced Heat Transfer	2	2	3
2	Advanced Fluid Mechanics	2	2	3
3	Advanced thermodynamics	2		2
4	Test Rigs Design, Measurements, and Data Analysis.	2	2	3
5	Advanced Applied Mathematics	2		2
6	English Language	2		2
	Total	12	4	14

Second Course - Specialized

	Subject	Theoretical	Practical	Units
1	Advanced Heat Exchangers Design	2	2	3
2	Computational Fluid Dynamics(CFD)	2	2	3
3	Exergy Analysis for Thermal Systems	2		2
4	Elective Subject#	2		2
5	Elective Subject#	2		2
6	English Language	2		2
	Total	12	4	14

Elective Subjects

	Subject	Theoretical	Practical	Units
1-1	Design and Optimization of Air-Conditioning Systems	2		2
1-2	Mixed Refrigerants and Low Temperature Application	2		2
1-3	Design and Optimization of Refrigeration Systems	2		2
2-1	Advanced Power Plants Engineering	2		2
2-2	Fluid and Turbo Machinery	2		2
2-3	Combustion dynamic and environment	2		2
	Total Available	4		4

 # Elective Objects Either Group-1 or Group-2

الفصل الاول- عام
First course - general

الوحدات	عدد الساعات			انتقال حراره متقدم الفصل الاول-عام **Advanced Heat Transfer**
	مجموع	عملي	نظري	
3	4	2	2	

BASIC CONCEPTS:

- Fourier's Law of Conduction, Conservation of Energy, Differential Formulation of the Heat Conduction in Rectangular Coordinates, The Heat Conduction Equation in Cylindrical and Spherical Coordinates, Boundary Conditions, Surface Convection: Newton's Law of Cooling, Surface Radiation: Stefan-Boltzmann Law, Examples of Boundary Conditions.

- Extended surfaces analysis: Convection at Surface, Boundary Conditions, Steady State Applications, Constant Area Fins with Surface Convection, Fin Efficiency, Moving Fins, Application of Moving Fins, Variable Area Fins, Graphically Presented Solutions to Fin Heat Transfer Rate.

MULTI-DIMESIONAL AND UNSTEADY STATE CONDUCTION:

- The Heat Conduction Equation, Method of Solution and Limitations, Homogeneous Differential Equations and Boundary Conditions, Sturm-Liouville Boundary-Value Problem (Orthogonality). Procedure for the Application of Separation of Variables Method, Cartesian Coordinates, Cylindrical Coordinates, Non-homogeneous Differential Equations, Non-homogeneous Boundary Conditions: The Method of Superposition.

- Transient Conduction in Plates, Non-homogeneous Equations and Boundary Conditions, Transient Conduction in Cylinders, Transient Conduction in Spheres, Time Dependent Boundary Conditions.

FUNDAMENTALS OF THERMAL RADIATION:

BASIC CONCEPTS: Electromagnetic Spectrum, Thermal Radiation, Blackbody Radiation, Stefan–Boltzmann law, Max Planck's law, Radiation Intensity, Incident Radiation, The Irradiation, Radiosity, Radiative Properties, Kirchhoff's law, Greenhouse Effect, Effective Sky Temperature, Solar Heat Gain Through Windows, View Factor relations, Radiation Exchange Between Black Surfaces, Radiation Exchange Between Non-Black Surfaces (opaque, diffuse, and gray).

RADIATIVE HEAT TRANSFER:

Net Radiation Heat Transfer to or from a Surface, Net Radiation Heat Transfer between Any Two Surfaces, Radiation Heat Transfer in Two-Surface Enclosures, Radiation Heat Transfer in Three-Surface Enclosures, Radiation Shields, Radiation Effect on Temperature Measurements, Radiation Exchange with Emitting and Absorbing Gases.

CONVECTION:

BASIC CONCEPTS: Important Factors in Convection Heat Transfer, The Continuum and Thermodynamic Equilibrium Concepts, Differential Formulation of Basic Laws, Conservation of Mass Momentum and Energy in (Cartesian, Cylindrical), Solution to the Temperature Distribution, Boundary Conditions, Non-dimensional Form of the Governing Equations: Dynamic and Thermal Similarity Parameters, Dimensionless Variables, Dimensionless Form of Governing Equations, The Nusselt Number, Scale Analysis, Couette Flow, Poiseuille Flow, Rotating Flow.

BOUNDARY LAYER FLOW: APPLICATION TO EXTERNAL FLOW: The Boundary Layer Concept, Simplification of the Governing Equations (Momentum and Energy Equation), Boundary Layer Equations for Steady Laminar Flow over Semi-infinite Flat Plate (Uniform and Variable Surface Temperature), Blasius Solution, Pohlhausen's Solution. The Integral Method: Differential vs. Integral Formulation, Integral Method Approximation, Integral Formulation of the Basic Laws (Conservation of Mass, Momentum, and Energy). Flow Field and Temperature Solution (Uniform Flow over a Semi-infinite Plate), Uniform Surface Flux.

- **FREE CONVECTION:** Features and Parameters of Free Convection, Governing Equations, Boundary Conditions, Laminar Free Convection over a Vertical Plate (Uniform Surface Temperature), Laminar Free Convection over a Vertical Plate (Uniform Surface Heat Flux). Integral Method, Comparison with Exact Solution for Nusselt Number.
- **CORRELATION EQUATIONS (FORCED AND FREE CONVECTION):** Experimental Determination of Heat Transfer Coefficient *h*, External Forced Convection Correlations, Internal Forced Convection Correlations, Free Convection Correlations.

MULTI-PHASE FLOW AND HEAT TRANSFER:
Introduction to Two-Phase Flow

- Definition of basic variables
- Two-phase flow pressure gradient equation
- Flow patterns and flow pattern maps.

ONE DIMENSIONAL FLOW:

- One dimensional steady homogenous flow
- One dimensional steady separated flow model
  - Phases are considered together but their velocities differ.
  - Phases are considered separately, flow with phase change.

BOILING AND CONDENSATION:
Heat transfer in boiling and condensation:

- Heat transfer during boiling
  - Boiling of saturated liquid.
  - Boiling heat transfer correlations.
- Condensation Heat Transfer
  - Film condensation.
  - Condensation inside and outside different geometries.
  - Condensation heat transfer correlations.

REFERENCES:

1. Analysis of Heat and Mass Transfer, Eckert and Drake, McGraw Hill.
2. Fundamentals of Heat Transfer, Grober, Erk and Grigull, Mc Graw Hill.
3. Conduction Heat Transfer, Schneider, Addison Wesley.
4. Thermal Radiation, Siegel and Howell, McGraw Hill.
5. Heat, Mass and Momentum transfer, Rohsenow and Choi, Prentice Hall.
6. Two Phase Flow by Butterworth and Hewitt.

الوحدات	عدد الساعات			ميكانيك موائع متقدم الفصل الاول-عام **Advanced Fluid Mechanics**
	مجموع	عملي	نظري	
3	4	2	2	

- **Vectors and Tensors.**
- **The Properties of Continuum Fluid.**
- **Conservation Laws.**
- **Static Equilibrium.**

Integral Methods and Control Volume Approach:
- The Continuity equation.
- Momentum equation.
- Moment of Momentum equation.
- Energy equation.
- The second Law of Thermodynamics.
- Non-Inertial Control Volume.

Differential Methods:
- Fluid Kinematics and Elementary Fluid Motion.
- Surface and Body Forces.
- The Stress Field.
- Momentum Conservation and the Equation of Motion.
- Navier-Stokes Equations.
- Incompressible and Constant Properties Fluid.
- Cylindrical Coordinates.

Invicsid Flow:
- Euler's Equation.
- Unsteady Bernoulli's Equation.
- Flow over Curved Surfaces.

Internal Viscous Fluid Flow:
- Steady, One-Dimensional Rectilinear Flows.
- Steady, Axisymmetric Rectilinear Flows.
- Steady, Axisymmetric Torsional Flows.
- Steady, Axisymmetric Radial Flows.
- Transient One-Dimensional Unidirectional Flows.
- Steady Two-Dimensional Rectilinear Flows.

Laminar and Turbulent Boundary Layers:
- Differential Methods.
- Integral Methods.

Turbulent Fluid Flow.

Vorticity Dynamics.

Surface Tension Applications/ Formation of Bubbles and Droplets.

References:

1. Dennis, C. Prieve, A Course in Fluid Mechanicswith Vector Field Theory, 2002, Carnegie Mellon University.
2. White, Frank M.,Viscous Fluid Flow, 2000, McGraw Hill.

الوحدات	عدد الساعات			ديناميك حراري متقدم الفصل الاول-عام **Advanced Thermodynamics**
	مجموع	عملي	نظري	
2	2		2	

1 Introduction

1-1 **What Is Thermodynamics**?, How Do We Measure Things, Classical Mechanical and Electrical Units Systems, Chemical Units, Modern Units Systems, Potential and Kinetic Energies.,

1-2 **Thermodynamic Concepts**, The Language of Thermodynamics, Phases of Matter, System States and Thermodynamic Properties , Thermodynamic Equilibrium, Thermodynamic Processes, Pressure and Temperature Scales, The Zeroth Law of Thermodynamics ,The Continuum Hypothesis, The Balance Concept, The Conservation Concept, Conservation of Mass.

1-3 **Thermodynamic Properties**, The Trees and The Forest, Why are Thermodynamic Property Values Important, Some Exciting New Thermodynamic Properties, Quality. Thermodynamic Property Software.

2 The First Law of Thermodynamics

2-1 **The First Law of Thermodynamics and Energy Transport Mechanisms:** Emmy Noether and the Conservation Laws of Physics , Energy Transport Mechanisms, Point and Path Functions, Mechanical Work Modes of Energy Transport , Non-mechanical Work Modes of Energy Transport, Power Modes of Energy Transport, Work Efficiency, The Local Equilibrium Postulate, The State Postulate, Heat Modes of Energy Transport, Heat Transfer Modes, A Thermodynamic Problem Solving Technique.

2-2 First Law Closed System Applications

2-3 First Law Open System Applications

3 The Second Law of Thermodynamics

3-1 **Second Law of Thermodynamics and Entropy Transport** and Production Mechanisms, What Is Entropy, Carnot's Heat Engine and the Second Law of Thermodynamics, The Absolute Temperature Scale.

3-2 **Entropy Transport Mechanisms**, Differential Entropy Balance , Heat Transport of Entropy, Work Mode Transport of Entropy, Entropy Production Mechanisms, Heat Transfer Production of Entropy, Work Mode Production of Entropy ., Phase Change Entropy Production, Entropy Balance and Entropy Rate Balance Equations.

3-3 Second Law Closed System Applications.

3-4 **Second Law Open System Applications.**

4 **Thermodynamic Relations**, Kynning , Two New Properties: Helmholtz and Gibbs Functions, Gibbs Phase Equilibrium Condition , Maxwell Equations, The Clapeyron Equation, Determining u, h, and s from p, v, and T, ,Constructing Tables and Charts.

5 **State Relationship for Real Gases and Liquids:** Two parameters equations of state, Three parameters equations of state, State equations for Liquids.

6 **Foundation of non-Equilibrium Thermodynamics:** Local Equilibrium, Local Entropy Production, Balance Equation for Concentration, Energy Conservation in Open Systems, The Entropy Balance Equation, Entropy Production.

7 **Mixtures of Gases and Vapors,**Wprowadzenie, Thermodynamic Properties of Gas Mixtures, Mixtures of Ideal Gases, Psychrometrics, The Adiabatic Saturator, The Sling Psychrometer, Mixtures of Real Gases.

8 **Chemical Thermodynamics**, Einführung (Introduction), Stoichiometric Equations, Organic Fuels, Fuel , Standard Reference , Heat of Formation, Heat of Reaction, Adiabatic Flame Temperature, Maximum Explosion Pressure, Entropy Production in Chemical Reactions, Entropy of Formation and Gibbs Function of Formation, Chemical Equilibrium and Dissociation, Rules for Chemical Equilibrium Constants, The van't Hoff Equation, Fuel Cells.

9 Introduction to Statistical Thermodynamics (Balmer): Why Use a Statistical Approach? Kinetic Theory of Gases, Equipartition of Energy, Quantum Statistical Thermodynamics, Monatomic Maxwell-Boltzmann Gases.

References:

1 Robert T. Balmer" Modern Engineering Thermodynamics", 2011 Elsevier Inc.

2 Claus borgnakke richard e. Sonntag" fundamentals of thermodynamics" John Wiley & Sons, Inc. 2009.

3 Michael j . m o r a n, howa r d n . s h a p i ro, dai s i e d . b o e t tner, marg a r e t b . bai l e y "fundamenta l s o f engineering Thermodynamics" Jo h n Wi l e y & S o n s , I n c, 2011.

4 Yunus A. Cengel and Michael A. Boles. " Thermodynamics an engineering approach" 2008 The McGraw-Hill Companies, Inc.

الوحدات	عدد الساعات			تصميم اجهزه الاختبار والقياسات وتحليل البيانات الفصل الاول-عام **Test Rigs Design, Measurements, and Data Analysis.**
	مجموع	عملي	نظري	
3	4	2	2	

Basic Concepts: The Generalized Measurement System, System Response, Experimental Planning, The Role of Uncertainty analysis in Experimental Planning,

Analysis of Experimental Data: Causes and Types of Experimental Errors, Error Analysis on a Commonsense Basis, Uncertainty Analysis, Evaluation of Uncertainties for Complicated Data Reduction, Statistical Analysis of Experimental Data, Probability Distribution, Comparison of Data with Normal Distribution, General Analysis and Curve Fitting,

Basic Electrical Measurements and Sensing Devices: Forces of Electromagnetic Origin, Waveform Measures, Basic Analog Meters, Basic Digital Meters, Basic Input Circuits, Amplifiers, Transformers, Power Supplies, Signal Conditioning, Kinds of Voltmeters, The Oscilloscope, Output Recorders, Transducers, Photovoltaic Cells,

Measurements:
Displacement: Gage Blocks, Optical Methods, Pneumatic, Displacement Gage.
Area: Planimeter, Graphical and Numerical methods, Uncertainty.
Pressure: Mechanical Devices, Dead-Weight Tester, Bourdon Gage, Diaphragm and Bellows, Bridgman, McLedo, Other Electrical Gages.
Flow: Positive Displacement Methods, Flow-Obstruction Methods, Drag Effects, Hot-Wire and Hot-Film Anemometers, Magnetic Flowmeter, The Laser Doppler Anemometer, Smoke Methods, Pressure Probes.
Temperature: Ideal Gas Thermometer, Mechanical Effects, Electrical Effect, Thermocouples: (Analysis, Rules, kinds, calibration), Radiation Effect

Thermal and Transport Property Measurements: Thermal Conductivity (Solids, Liquids, Gases), Viscosity, Gas Diffusion, Calorimetry, Convection Heat Transfer, Humidity, Heat Flux, Emissivity, Solar Radiation.

Air Pollution: Air Pollution Standards, General Air-Sampling Train, Combustion Products Measurements,

Data Acquisition and Processing: General Data Acquisition System, Signal Conditioning Revisited, Data Transmission, Analog to Digital and Digital to Analog Conversion, Data Storage and Display, The Program as a Substitute for Wired Logic.

Design of Experiments: Characteristics of Types of Experiments, Experiment Design Factors, Experiment Design Protocol and Examples,

الوحدات	عدد الساعات			رياضيات تطبيقيه متقدمه
	مجموع	عملي	نظري	الفصل الاول-عام
2	2		2	**Advanced Applied Mathematics**

1. Introduction
- Basic Concepts and Ideas
- Review of first order differential equations

2. Ordinary Differential Equations
- Homogeneous second order differential equations
- Nonhomogeneous second order differential equations
- Homogeneous higher order differential equations
- Nonhomogeneous higher order differential equations
- Applications of second and higher order differential equations

3. Series Solution of Differential Equations-Legendre Polynomial, Bessel functions.
- Legendre's equation, Legendre Polynomials
- Bessel's equation, Bessel functions of first and second kinds
- Orthogonal functions, Sturm-Liouville problems

4. Fourier Series and Integrals
- Functions of any period, Even and Odd functions
- Complex Fourier series
- Fourier Integral
- Fourier cosine and sine transforms

5. Partial Differential Equations
- Basic concepts, modeling
- Solution by separation of variables method
- Numerical solution of partial differential equations

6. Vector Analysis
- Applications of vector multiplication
- Differentiation of vectors
- Directional derivative, gradient
- The divergence theorem

7. Coordinate Transformations ,Tensor analysis

- Linear and Orthogonal transformation
- Curvilinear coordinates
- Tensor analysis, uses of tensors
- General coordinate system

8. Conformal Mapping

- Mapping,Conformal mapping
- Linear fractional transformation
- Applications of conformal mapping

References:

- Advanced Engineering Mathematics, Erwin Kreyszig,John Wiley&Sons.

- Mathematical Methods in the Physical Sciences, Mary L, boas, John Wiley & Sons.

- Advanced Engineering Mathematics, Alan Jeffrey, Academic Press.

- Partial Differential Equations ,Nakhile H. Asmar, Pearson Prentice Hall.

الفصل الثاني ـ متخصص
Second Course - Specialized

الوحدات	عدد الساعات			مبادلات حراريه متقدمه الفصل الثاني- متخصص **Advanced Heat Exchangers**
	مجموع	عملي	نظري	
3	4	2	2	

No.	Subject	
1	• Classification of Heat Exchangers. • Overview of Heat Exchanger Calculations.	
	Thermal Design Theory: o The ε-NTU Method. o The P-NTU Method. o F Factors. o The Ψ-P and P1−P2 Methods. o The Λ–Π Method.	
2	• Heat Exchanger Design Methodologies: o Process and Design Specifications. o Thermal and Hydraulic Design. o Mechanical Design. o Manufacturing Considerations. o Trade-off Factors. o Optimum Design. • Heat Exchanger Design Procedures.	
3	Practical Considerations: o Pressure Drop. o Longitudinal and Transverse Wall Heat Conduction Effects. o Non-uniform Overall Heat Transfer Coefficients. o Flow Mal-distribution and Header Design. o Extended surface, leakage, and other factors.	
4	Heat Exchanger Surface Geometrical Characteristics: o Tubular Heat Exchangers. o Tube-Fin Heat Exchangers. o Plate-Fin Heat Exchangers. o Regenerators with Continuous Cylindrical Passages. o Shell-and-Tube Exchangers with Segmental Baffles. o Gasketed Plate Heat Exchangers.	
5	Thermodynamic Modeling and Analysis: o First Law of Thermodynamics Modeling. o Irreversibilities and Entropy Generation. o 1–2 TEMA J Shell-and-Tube Heat Exchanger.	
6	Selection of Heat Exchangers and Their Components:	

	○ Selection Guidelines and Criteria. ○ Performance Evaluation Criteria. ○ Major Exchanger Types.	
7	Computer Aided Design of Heat Exchangers.	
8	Fouling and Corrosion.	

References:

4. Ramesh, K. Shah and Dusan, P. Sekulic, Fundamentals of heat exchanger design, 2003, John Wiley & Sons, Inc.
5. Hoffmann, K.A.; Chiang, S.T., Heat Transfer Calculations, 2011, McGraw Hill.
6. Jovan, Mitrovic, Heat Exchangers – Basics Design Applications, 2012, InTech.

الوحدات	عدد الساعات			ديناميك الموائع الحسابي(CFD)
	مجموع	عملي	نظري	الفصل الثاني- متخصص
3	4	2	2	Computational Fluid Dynamics(CFD)

1- Review of basic fluid mechanics and the governing (Navier-Stokes) equations.

2- Techniques for solutionof PDEs:
- Finite difference method.
- Finite element method.
- Finite volume method.

3- Finite volume method(FVM) in one-dimension:
- Differencing schemes.
- Steady and unsteady calculations.
- Boundary conditions.

4- FVM discretizationin two and three dimensions

5- Convection – Diffusion Problems.

6- SIMPLE algorithm and flow fieldcalculations.

7- SIMPLER and other algorithms.

8- Commercial softwares FLUENT, ANSYS and CFX.

References:

1. Tannehill, J.c.; Anderson, D.A.;andPletcher, R.H.,Computational Fluid Mechanics and Heat Transfer, 1997, Taylor & Francis.
2. Hoffmann, K.A.; Chiang, S.T.,Computational Fluid Dynamics for Engineers, 2000, Engineering Education Systems.
3. Peyret, R. and Taylor, T. D.,Computational Methods for Fluid Flow, 1983,Springer-Verlag.

الوحدات	عدد الساعات			تحليل الاكسيرجي للنظم الحرارية الفصل الثاني- متخصص **Exergy Analysis for Thermal Systems**
	مجموع	عملي	نظري	
2	2		2	

1- Entropy; order and disorder and reversibility and irreversibility, characteristic of entropy, significance of entropy, Carnot's contribution, the Clausius inequality.

2- Exergy; The quantity exergy, Exergy analysis, characteristics of Exergy, The reference environment, Exergy vs. energy, Exergy efficiencies, solar Exergy and the earth. General examples.

3- Exergy and energy analysis. Why energy and exergy analysis. Balance for mass, energy and entropy, Exergy of system and flow, Reference environment. Efficiencies and other measures of merit.

4- Exergy, environment and sustainable development, environment concerns, potential solution to environmen

5- t problems. Energy and environmental problems. Exergy and sustainable development.

6- Application of Exergy in industry; advantages and benefits of using exergy, advantage and benefits of using exergy. Understanding energy conservation through exergy. Disadvantages and drawbacks of using exergy.

7- Exergy analysis of psychrometric processes.

8- Exergy analysis of heat pump systems.

9- Exergy analysis of thermal energy storage systems.

10- Exergy analysis of renewable energy systems.

11- Exergy analysis of steam power plants.

12- Exergy analysis of Chemical Reactions, First law analysis of reacting system, enthalpy and internal energy of combustion, heat of reaction adiabatic flame temperature, third law of thermodynamics and absolute entropy, second law analysis of reacting systems.

References:

1- Adrian Bejan: Advanced engineering thermodynamics" John Wiley & sons. INC. 2006.
2- Ibrahim Dincer, Marc A. Rosen "EXERGY: Energy, Environment and Sustainable Development" Elsevier, 2007.
3- Ibrahim Dinc¸er, Mehmet Kanoˇglu" refrigeration systems and applications" John Wiley and Sons, Ltd., 2010.
4- Claus Borgnakke Richard e. Sonntag" fundamentals of thermodynamics" John Wiley & Sons, Inc. 2009.

الفصل الثاني - متخصص - اختياري
Second Course – Specialized – Electives

الوحدات	عدد الساعات			تصميم وتحسين اداء أنظمةِ التبريدِ الفصل الثاني- متخصص - اختياري **Design and Optimization of Refrigeration Systems**
	مجموع	عملي	نظري	
2	2		2	

1- Compressor rating and selection- reciprocating, screw, Scroll and centrifugal compressors based on applications

2- Evaporators: types, thermal design, effect of lubricants accumulation, draining of lubricants, selection and capacity control.

3- Condenser: types, thermal design, purging, selection and capacity control.

4- Selection of expansion devices, Design of refrigerant piping refrigeration system controls and safety devices, Solenoid valves, suction and evaporator pressure regulators, Thermal Insulation.

5- Motor selection: Single phase, Three phase, Starters, Constant speed and Variable speed drive.

6- Associated devices: high pressure receiver thermal design of low pressure receiver, accumulator, Filters, driers, oil separators, relief valves, safety valves, high and low pressure cut out, thermostats, water regulators etc.

7- Analysis of the complete vapour-compression-system and determination of 'Balance Points' using Graphical and Analytical methods, system simulation.

References:

1- Refrigeration & Air Conditioning - By C.P. Arora
2- Refrigeration & Air Conditioning - By Manohar Prasad
3- Principles of Refrigeration - By Roy J.Dossat
4- Air Conditioning Engineering - By W,P.Jones
5- Heating, Ventilating and Air Conditioning - By McQuistion, Parker &Spitler
6- Refrigeration & Air Conditioning Data Book – Manohar Prasad
7- ASHRAE Handbook – Fundamentals
8- Refrigeration & Air Conditioning-Stoecker& Jones
9- Refrigeration & Air condoning – By P.L.Ballaney

الوحدات	عدد الساعات			وسائط التبريد المختلطه وتطبيقات الحراره المنخفظه الفصل الثاني- متخصص - اختياري **Mixed Refrigerants and Low Temperature Application**
	مجموع	عملي	نظري	
2	2		2	

No.	Subject	No. of Lectures
1	• Mixed Refrigerants o Azeotropic o Zeotropic • Thermodynamic description of vapour liquid equilibrium of multicomponent system. • Boiling diagrams. • *K* values and relative volatility values. • Raoult's Law. • Thermodynamic relations and functional forms.	2
2	Optimum mixture composition / maximization of exergy efficiency.	1
3	Vapour compression cycles with Zeotropic mixtures. o Lorenz Cycle. o Auto Cascade cycle. o Methods for comparing the performance of pure and mixed refrigerants cycles.	1
4	Methods for Improving the Cycle Efficiency	1
5	Experimental Performance Measurements	2
6	Refrigerant Mixtures in Refrigeration Applications o Single evaporator. o Dual evaporator o Lorenz – Meutzner cycle. o Modified Lorenz – Meutzner cycle.	2
7	Refrigerant Mixtures in Heat Pump Applications	2
8	Transport Phenomena of mixed refrigerants: o Boiling. o Condensation. o Pressure Drop.	2
9	Application measures.	2

References:

1. Venkatarathnam, G., "Cryogenic Mixed Refrigerant Processes", Springer, 2008.

2. Reinhard R., Yunho H., "Vapor compression heat pumps with refrigerant mixtures", Taylor and Francis group, CRC press, 2005.

3. Richard, J., Steve, P., and Eric, L., "Thermodynamic properties of cryogenic fluids", Plenum press, 1997.

4. Domanski, P., Didion, D., "Equation of state based thermodynamic charts for nonazeotropic

الوحدات	عدد الساعات			تصميم وتحسين اداء أنظمةِ تكييف الهواء الفصل الثاني- متخصص - اختياري Design and Optimization of Air-Conditioning System
	مجموع	عملي	نظري	
2	2		2	

The design process

- Design process context
- Design versus analysis
- Design phase
- Interaction between HVAC&R and other building system
- HVAC system selection Issues
- Computers and HVAC design
- Codes and standard

Occupant comfort and health

- Thermal comfort
- Indoor air quality
- Room air distribution
- Noise and vibration

Load calculation

- Outdoor and indoor design condition
- Internal and external loads
- Calculation methods
- Computer input and outputs

Components

- Cooling source equipment
- Heating source equipment
- Heat transfer equipment
- Pumps, valves

- Piping
- Ductwork

All air HVAC systems

- Advantages and disadvantages
- System concept and basic psychrometric
- Special design conditions
- Useful equations for air system design
- Single zone all air system
- Variable air volume systems
- Reheat system
- Dual duct system
- Multi zone system
- Simple roof type system

Air and water systems

- Applications
- Primary air system
- Water side systems
- Refrigeration load
- Electric heating system
- Closed loop water source heat pumps

All water systems

- Applications
- System concepts
- Two pipe system
- Four pipe system

- Three pipe systems
- Piping design consideration
- Variables speed pump operation
- Terminals
- System evaluation and comparison
- Design sequence

Special HVAC systems

- Variable refrigerant volume VRV
- Variable refrigerant flow VRF

الوحدات	عدد الساعات			هندسة محطات قدره متقدم الفصل الثاني- متخصص - اختياري **Advanced Power Plants Engineering**
	مجموع	عملي	نظري	
2	2		2	

- Types of Power Plants
  - Thermal Power Plants
  - Nonconventional Power Plants
- Power Plant Economics and VariableLoad Problem.

Advanced Power Cycles:
- Combined
- Binary
- Kalina

Thermal Power Plants Equipment:
- Boilers.
- Superheaters.
- Economizers.
- Condensers.
- Combustion Chambers and Gas Loop.
- Turbines.

Methods for Improving the Cycle Efficiency.

Practical Performance Measurements

Steam Turbines:
- Axillaries.
- Governing and Control.

Computer Aided:
- Performance Calculation.
- Design.
- Control.

Optimized startup Processes and Unit Control

Pollution:
- Particulate, Gaseous pollutants.
- Thermal Pollution.
- Solid Waste Pollution.
- Pollution Control Strategies.

References:

5. Raja, A.K.; Srivastava, Amit P.;Dwivedi,Manish,Power Plants Engineering, 2006, New Age International Publishing.
6. Kiameh, P., Power Generation Handbook, 2002, McGraw Hill.
7. Leyzerovich, Alexander S., Steam Turbines forModern Fossil-FuelPower Plants, 2008, Fairmont Press.
8. Rolf,Kehlhofer; Bert,Rukes, Combined-Cycle Gas and Steam Turbine Power Plants, 2009, Pen Well Corp. 3rd Ed.

مكائن هيدروليكيه وتوربينيه الفصل الثاني- متخصص - اختياري **Fluid and Turbo Machinery**	عدد الساعات			الوحدات
	نظري	عملي	مجموع	
	2		2	2

Basic Concepts: Introduction to Dynamics of Fluid Flow, Impulse Momentum Principle, Force Exerted on a Stationary Vane or Blade, Absolute and Relative Velocity Relations, Force on a Moving Vane or Blade, Torque on Rotating Wheel.

Hydraulic Turbines: Hydraulic Power Plant, Classification of Turbines, Similitude and Model Testing, Model and Prototype, Turbine Efficiencies, Euler Turbine Equation, Pelton Turbine (Power Development, Torque and Power and Efficiency Variation with Speed Ratio).

Reaction Turbines: Francis Turbines (main components, Energy Transfer and Efficiency), Axial Flow Turbines, Cavitations in Hydraulic Machines, Governing of Hydraulic Turbines,

Rotodynamic Pumps: Centrifugal Pumps Classification, Pressure Developed by the Impeller, Energy Transfer by Impeller, Slip and Slip Factor, Losses in Centrifugal Pumps, Effect of Outlet Blade Angle, Pump Characteristics, Operation of pumps in serial and Parallel, Specific Speed and Significance, Cavitation, Axial Flow Pump: Power Transmitting Systems, Fluid Coupling, Torque Converter.

Reciprocating Pumps: Description and Working, Flow Rate and Power, Indicator Diagram, Acceleration Head, Minimum Speed of Rotation of Crank, Friction Head, Air Vessels, Flow into and out of Air vessel, Rotary Positive Displacements, Gear Pump, Lobe Pump, Vane Pump,

Turbomachinery: Compressible gas flow relations, Stagnation temperature and pressure, Compressible fluid analysis, The inherent unsteadiness of the flow within Turbomachines, Definitions of efficiency (turbines, compressors, Nozzles and diffusers).

Axial-flow Turbines: Two-dimensional Theory: Velocity diagrams of the axial turbine stage, Thermodynamics of the axial turbine stage, Stage losses and efficiency, Types of axial turbine design, Stage reaction (Zero reaction stage, 50 per cent reaction stage).

Axial-flow Compressors and Fans: Two-dimensional analysis of the compressor stage, Velocity diagrams of the compressor stage, Thermodynamics of the compressor stage, Stage loss relationships and efficiency, Reaction ratio, Choice of reaction,

الوحدات	عدد الساعات			ديناميكية الاحتراق والبيئه الفصل الثاني- متخصص - اختياري **Combustion dynamic and environment**
	مجموع	عملي	نظري	
2	2		2	

1. Introduction
- Basic principles
- Importance of combustion
- Combustion and pollution problems

2. Thermodynamics of Combustion
- Enthalpy of formation
- Enthalpy of reaction
- First and second law analysis of reacting systems
- Chemical equilibrium
- Adiabatic and equilibrium flame temperature

3. Kinetics of Combustion
- Law of mass action, reaction rate, simple and complex reaction
- Chain reaction steady state and partial equilibrium approximation
- Chain explosion, explosion limits and oxidation characteristics

4. Flame Phenomena in Premixed Combustible Gases
- Premixed flames structure and propagation in homogeneous gas mixtures
- Simplified Rankine Hugoniot relations
- Laminar flame structure, theories of flame propagation
- Calculation of flame speed, flame speed measurements.
- Stability limits of laminar flames, flammability limits and quenching distance
- Mechanisms of flame stabilization in laminar and turbulent flows
- Diffusion flames, comparison of diffusion with premixed flame

5. Burning of Condensed Phases
- General mass burning considerations, evaporation coefficient
- Combustion of fuel droplets in a quiescent and convective environment
- Combustion of fuel sprays

6. Ignition

- Concepts of ignition, chain ignition
- Thermal spontaneous ignition
- Forced ignition

7. Environmental Combustion Considerations

- Combustion generated pollution and its control
- Formation and reduction of nitrogen oxides NOx
- Sulphur oxides SOx emissions
- Particulate formation
- Stratospheric Ozone

References:

- Combustion, Irvin Glassman, Academic Press. 2008.

- Combustion Fundamentals, Strehlow, Mc Graw Hill.

- Propellants and Explosives, Naminosuke Kubota , 2007 Wiley-VCH Verlag, 2007.

- Fundamentals of Internal Combustion Engine, H.N. Gupta, Asoke K. Ghosh, 2009