RK.UNIVERSITY

SYLLABUS

SCHOOL OF ENGINEERING
ACADEMIC YEAR - 2019-20
DEFINATION OF ONE CREDIT:

PROGRAM: M. TECH – THERMAL SCIENCE (MECHANICAL ENGINEERING)
SEMESTER – I (Batch - 2019-21)

1. **Lecture (L):** 1 hour / week / semester,
2. **Practical (P):** 2 hour / week / semester,
3. **Tutorial (T):** 2 hour / week / semester.

TEACHING SCHEME

Course Code	Course Name	Teaching Hours			SSH	Credits	Audit course	CIE	PSEE	Remarks if any
		Theory	Tutorial	Practical						
RM103	Research Methodology and IPR	3	0	0	1	3	N	Y	N	
TH111	Applied Thermodynamics	4	0	0	2	4	N	Y	N	
TH113	Advanced Heat and Mass Transfer	3	2	0	2	4	N	Y	N	
TH116	Advanced Gas Dynamics	3	0	0	2	3	N	Y	N	
TH117	Advanced Fluid Dynamics	3	2	0	2	4	N	Y	N	
TH118	Thermal Simulation Using LabVIEW	1	0	2	1	2	N	Y	Y	
TH9XX	Elective - I	3	0	2	3	4	N	Y	Y	Any One Offered Elect. - I
PG101	Software Lab - I	0	0	2	3	1	N	Y	Y	
	TOTAL	**20**	**4**	**6**	**16**	**25**				
		Total Teaching Hours 30								

N- No
Y – Yes

CIE – Continuous internal evaluation
PSEE – Practical semester end examination including ITD, Dissertation, Industrial project, Industrial training etc.
SSH - Self-study hours

HOD **Director**

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SCHOOL OF ENGINEERING
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PROGRAM: M. TECH – THERMAL SCIENCE (MECHANICAL ENGINEERING)
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1. **Lecture (L):** 1 hour / week / semester,
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Elective – I										
Course Code	**Course Name**	**Teaching Hours**			**SSH**	**Credits**	**Audit course**	**CIE**	**PSEE**	**Remarks if any**
		Theory	**Tutorial**	**Practical**						
TH923	Theory and Design of Cryogenic Systems	3	0	2	3	4	N	Y	Y	Any One Offered Elect. - I
TH924	Analysis and Design of I.C Engines	3	0	2	3	4	N	Y	Y	
TH925	Solar Energy Conservation Systems	3	0	2	3	4	N	Y	Y	

N- No
Y – Yes

CIE – Continuous internal evaluation
PSEE – Practical semester end examination including ITD, Dissertation, Industrial project, Industrial training etc.
SSH - Self-study hours

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SYLLABUS

Course Title	RESEARCH METHODOLOGY AND IPR
Course Code	RM103
Course Credit	Lecture : 03
	Practical : 00
	Tutorial : 00
	Total : 03

Course Learning Outcomes

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

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

Detailed Syllabus

Sr. No.	Name of chapter & Details	Hours Allotted
	Section - I	
1	**Unit 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	7
2	**Unit 2:** Effective literature studies approach, analysis Plagiarism, Research ethics	5

3	**Unit 3:** Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee	**9**
	Total	**21**
Section – II		
5	**Unit 4:** 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	**8**
6	**Unit 5:** Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications	**5**
7	**Unit 6:** 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	**8**
	Total	**21**

Instructional Method and Pedagogy:

- Lectures will be conducted with the aid of multi-media projector, black board Transparencies etc.
- Assignments and Exercise will be given to the students for each unit/topic and will be evaluated at regular interval.
- Surprise tests/Quizzes/Seminar/Tutorials will be conducted.

Reference Books/Text book:

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

Course Title	APPLIED THERMODYNAMICS
Course Code	TH111
Course Credit	Lecture : 04
	Practical : 00
	Tutorial : 00
	Total : 04

Course Learning Outcomes

After Successful completion of the above course; students will be able to:

- **Understand** fundamental concepts and terminologies of thermodynamics.
- **Apply** First law and Second law of thermodynamics to **analyze** closed and open system problems.
- **Apply** concept of reversibility; Entropy and Exergy in thermodynamics system design.
- **Estimate** thermodynamic properties of substances in gas and liquid states using Maxwell relation and Combustion equations.

Detailed Syllabus

Sr. No.	Name of chapter & Details	Hours Allotted
	SECTION-I	
1	**Review of Basic Concepts** System and surroundings; state parameters; thermal equilibrium and Zeroth law of thermodynamics; Thermodynamic equilibrium; Forms of energy and concept of work and heat; First law of thermodynamics - its applications and limitations.	**6**
2	**Second Law of Thermodynamic** Reversibility and irreversibility; statements of second law and their discussion. Equivalence of Kelvin-Planck and Clausius statements; Carnot engine and Carnot refrigeration; Thermodynamic temperature scale and absolute zero temperature; Clausius theorem and Clausius inequality	**10**

3	**Concept of Exergy and Entropy** Exergy for closed system; Entropy generation; entropy balance for closed system; behavior of gases; Equations of state. Entropy and reversibility; Entropy and irreversibility; Irreversible part of the second law; Heat and entropy in irreversible processes; Entropy and Non-equilibrium states; Principle of increase of entropy.	**12**
	Total	**28**

	SECTION-II	
4	**Thermodynamic Relations:** Phase rule without chemical reaction; chemical potential of ideal gases;T-dsequations for simple compressible systems; Helmholtz and Gibbs functions; Maxwell relations; generalized relations for changes in enthalpy; entropy and internal energy; equations for specific heats; Clausius Clapeyron equation; Joule-Thomson and Joule coefficients; applications of thermodynamic relations.	**10**
5	**Variable Specific Heat** Factors affecting specific heat; classical analysis; Plank's quantum hypothesis; methods for considering variation in specific heats; use of temperature-internal energy-entropy (t-u-s) chart for air.	**9**
6	**Reactive Mixture (Combustion)** Combustion equations; Stoichiometric air; Excess air; Air -fuel ratio by volume & weight; Enthalpy of formation; Enthalpy and internal energy of combustion; Adiabatic flame temperature; Equilibrium constants.	**9**
	Total	**28**

Instructional Method and Pedagogy:

- At the beginning of course; the course delivery pattern; prerequisite of the subject will be discussed.
- Lectures will be conducted with the aid of multi-media projector; blackboard; OHP etc.
- Attendance is compulsory in lectures and tutorial.
- Minimum two internal exams will be conducted and average of two will be considered as a part of overall evaluation.
- Assignments based on course content will be given to the students at the end of each unit/topic and will be evaluated at regularly.
- Surprise tests/Quizzes/Seminar/Tutorials will be conducted.
- Tutorials and assignments are to be submitted as term-work in laboratory related to course contents.

Reference Books:

1. Yunus Cengel & Boles; “Thermodynamics – Engineering Approach” Tata McGraw-Hill; New Delhi.
2. P.K. Nag;” Engineering Thermodynamics”; Tata McGraw-Hill; New Delhi
3. R.K. Rajput “Engineering Thermodynamics”; Laxmi Publications; New Delhi
4. R.Yadav “Fundamentals of Engineering Thermodynamics “; Central Publishing House; Allahabad
5. J.P. Holman “Thermodynamics”; Tata McGraw-Hill.
6. YVC Rao “An introduction to Thermodynamics”; New Age publishers; New Delhi.
7. Robert Balmer “Thermodynamics – Theory & Application”; Jaico publication house.
8. Michael J. Moran & Haward N. Shapiro “Fundamentals of Engineering Thermodynamics”; John Wiley & sons (ASIA) Pvt. Ltd.
9. Adrian Bejan “Advanced Engineering Thermodynamics”; John Wiley and sons.USA
10. T.J.Kotas “The Exergy Method of Thermal Plant Analysis”;Exergon Publishing Company with Paragon Publishing.UK.

Additional Resources:

- http://nptel.ac.in/courses/112104113
- http://ocw.mit.edu/courses/chemistry/5-60-thermodynamics-kinetics-spring-2008/
- https://www.youtube.com/watch?v=UMs9GIrY4dw&list=PL4xAk5aclnUiyy5I6QsjJ_3rdKoO0q04I
- https://www.khanacademy.org/science/physics/thermodynamics

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SYLLABUS

Course Title	ADVANCED HEAT AND MASS TRANSFER
Course Code	TH113
Course Credit	Lecture : 03
	Practical : 00
	Tutorial : 01
	Total : 04

Course Learning Outcomes

After Successful completion of the above course; students will be able to:

- **Develop** an intuitive understanding of heat transfer by emphasizing the physics and physical arguments.
- **Understand** the basic mechanisms of heat transfer which conduction; convection and radiation; Fourier's law of conductions; Newton's law of cooling and Stefan-Boltzmann law of radiation.
- **Differentiate** between evaporation and boiling and gain familiarity with different types of boiling; also develop a good understanding of boiling curve and the different boiling regimes corresponding to different regions of boiling curve.
- **Understand** the phenomenon of condensation over vertical plate; inclined and horizontal plates; examine drop wise condensation.
- **Understand** the concentration gradient and the physical mechanism of mass transfer; understand the Flick's law of mass transfer and analyze simultaneous heat and mass transfer.

Detailed Syllabus

Sr. No.	Name of chapter & Details	Hours Allotted
	SECTION-I	
1	**Conduction:** Review of the basic laws of conduction; One dimensional steady state conduction with variable thermal conductivity and with internal distributed heat source; Extended surfaces-review and design considerations; Two-dimensional steady state conduction; Unsteady state conduction; solutions using Groeber's and Heisler's charts for plates; cylinders and spheres suddenly immersed in fluids.	14
2	**Convection:** Review of convection and radiation heat transfer laws; Natural and	14

	forced convection; Heat transfer in turbulent flow. Natural convection from extended surfaces; Eddy heat diffusivity; Reynold's analogy between skin friction and heat transfer;Von Karman; turbulent flow through circular tubes. Natural convection inside enclosures; Combined natural and forced convection	
	Total	**28**
	SECTION-II	
3	**Radiation:** Review of radiation principles. Radiation intensity; atmospheric and solar radiation; View factor relations; radiation heat transfer on black surfaces; Diffuse surfaces and the Lambert's Cosine law; Radiation through non-absorbing media; Hottel's method of successive reflections; Radiation exchange with emitting and absorbing gases.	**6**
4	**Boiling and Condensation** Boiling and boiling regimes; Bubble growth and nucleate boiling; Correlation of boiling heat transfer data; Laminar film condensation on vertical plates; Turbulent film condensation; Convective coefficient for film condensation on tubes.	**6**
5	**Mass Transfer:** Modes of mass transfer; concentrations; velocities and fluxes. Fick's law; general equation of mass diffusion in stationary media; Steady state diffusion through a plain membrane. Steady state equimolar counter diffusion; isothermal evaporation of water into air from a surface. Mass transfer coefficient; convective mass transfer.	**2**
	Total	**14**

Instructional Method and Pedagogy:

- At the beginning of course; the course delivery pattern; prerequisite of the subject will be discussed.
- Lectures will be conducted with the aid of multi-media projector; blackboard; OHP etc.
- Attendance is compulsory in lectures and tutorial.
- Minimum two internal exams will be conducted and average of two will be considered as a part of overall evaluation.
- Assignments based on course content will be given to the students at the end of each unit/topic and will be evaluated at regularly.
- Surprise tests/Quizzes/Seminar/Tutorials will be conducted.
- Tutorials and assignments are to be submitted as term-work in laboratory related to course contents.

Reference books:

1. R.K. Rajput; "Heat& Mass Transfer"; S. Chand & Co. New Delhi.
2. P. K. Nag; "Heat& Mass Transfer"; Tata McGraw Hill; New Delhi.
3. Arora & Domkundwar; "Heat & Mass Transfer"; Dhanpatrai and Co.; New Delhi
4. Mills and Ganesan; "Heat & Mass Transfer"; Pearson Publication; New Delhi
5. D.S.Kumar; "Heat and Mass transfer" ;S.K .Kataria& Sons
6. Yunus cengel; "Heat & Mass transfer"; Tata Mc-Graw Hill.

Additional Resources

1) http://nptel.ac.in/courses/112101097/
2) http://www.sciencedirect/science/journal/00179310/
3) http://www.learnerstv.com/Free-engineering-Video-lectures-ltv084-Page1.htm

RK UNIVERSITY

SYLLABUS

Course Title	**ADVANCED GAS DYNAMICS**
Course Code	**TH116**
Course Credit	Lecture : 03
	Practical : 00
	Tutorial : 00
	Total : 03

Course Learning Outcomes

After Successful completion of the above course; students will be able to:

- **Classify** the different fluid flow regimes.
- **Understand** the underlying physical mechanisms of compressible fluid flow.
- **Apply** the fundamentals of mathematics to derive comprisable flow relations for solution of fluid flow problems.
- **Determine** various flow parameters in different flow regimes with various flow conditions.
- **Apply** concepts of normal shock; oblique shock; fanno flow and Rayleigh flow for solving the real-world engineering problems.

Detailed Syllabus

Sr. No.	Name of chapter & Details	Hours Allotted
	SECTION-I	
1	**Review of Fundamentals:** Types of flow; Generalized continuity equation; momentum and energy equations; Euler and Navier-Stokes equations; integration of the momentum equation; The generalized Bernoulli's equation; Energy equations for flow and non-flow process.	**4**
2	**Basics of Compressible Flow:** Velocity of sound and its importance; Mach cone; Zone of silence; Compressibility; physical difference between incompressible; compressible; subsonic and supersonic flows; Three reference speeds; dimensionless velocity (Mach number); concepts of static and stagnation parameters and their relations.	**4**

3	**Isentropic Flow with Variable Area.** Comparison of Isentropic and Adiabatic processes; Mach number variation; Stagnation and Critical states; Area ratio as function of Mach number; Mass flow rate; flow through nozzles and diffusers; Use of Gas tables.	**6**
4	**Fanno Flow** The fanno curves, Fanno flow equations, Variations of flow properties with duct length, Tables and charts for fanno flow.	**7**
	Total	**21**
	SECTION-II	
5	**Flow with Normal Shock Waves.** Development of a shock wave. The governing equations; Prandtl-Meyer relation; Mach number downstream of the normal shock wave; Static pressure ratio across the shock; Temperature and density ratio across the shock; Stagnation pressure ratio and change in entropy across the shock; Impossibility of a shock in subsonic flow; strength of a shock wave; Determination of Mach number of supersonic flows. Tables and charts for normal shock waves.	**9**
6	**Oblique Shock Waves.** Concept and theory, Oblique Shock relations, Property variations, Supersonic compression, Tables and charts for oblique shock waves.	**6**
8	**Rayleigh Flow** The Rayleigh curves, Fundamental equations and Rayleigh flow relations, Variation of flow properties with heat transfer, Maximum heat transfer and choking, Tables and charts for Rayleigh flow.	**6**
	Total	**21**

Instructional Method and Pedagogy:

- At the beginning of course; the course delivery pattern prerequisite of the subject will be discussed.
- Lectures will be conducted with the aid of multi-media projector blackboard; OHP etc.
- Attendance is compulsory in lectures and laboratory.
- Minimum two internal exams will be conducted and average of two will be considered as a part of overall evaluation.
- Assignmentsbasedoncoursecontentwillbegiventothestudentsattheendof each unit/topic and will be evaluated at regularly.
- Surprise tests/Quizzes/Seminar/Tutorials will be conducted.
- The course includes a laboratory; where students have a no opportunity to build an appreciation for the concepts being taught in lectures.
- Tutorials and assignments are to be submitted as term-work in laboratory related to course contents.

Reference Books:

1. E Rathakrishnan;" Gas Dynamics"; PHI Learning Private Limited.
2. E Rathakrishnan; "Applied Gas Dynamics"; John Wiley & Sons.
3. S.M. Yahya; "Fundamentals of Compressible flow"; New Age International (P) Limited.
4. John David Anderson; "Modern Compressible flow"; Tata McGraw-Hill
5. Patrick H. Oosthuizen; William E. Carscallen; "Introduction to Compressible Fluid Flow"; Taylor & Francis Group.
6. Ali Campbell & lennings; "Gas dynamics";
7. Maurice Joseph Zucrow; Joe D. Hoffman; "Gas Dynamics"; Krieger Pub. Co.
8. Yuan Prentice Hall Mechanics; "Foundation of Fluid".

Additional Resources:

4) http://nptel.ac.in/downloads/101106044/
5) http://en.wikipedia.org/wiki/Gas_dynamics
6) http://www.mechanical.in/gas-dynamics-and-jet-propulsion/

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SYLLABUS

Course Title	**ADVANCED FLUID DYNAMICS**
Course Code	**TH117**
Course Credit	Lecture : 03
	Practical : 01
	Tutorial : 00
	Total : 04

Course Learning Outcomes

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

- **Apply** the fundamentals of kinematics and conservation laws of fluid flow systems.
- **Apply** the principles of high and low Reynolds number flows to fluid flow systems.
- **Review** the concepts of boundary layer and flow in transition.
- **Analyze** and **apply** the fundamentals of turbulent flow to various fluid flow systems.

Detailed Syllabus

Sr. No.	Name of chapter & Details	Hours Allotted
	Section - I	
1	**Basic Concepts and Fundamentals** Definition and properties of Fluids, Fluid as continuum, Langragian and Eulerian description, Velocity and stress field, Fluid statics, Fluid Kinematics	**5**
2	**Governing Equations of Fluid Motion** Reynolds transport theorem, Integral and differential forms of governing equations: mass, momentum and energy conservation equations, Navier- Stokes equations, Euler's equation, Bernoulli's Equation.	**8**
3	**Exact solutions of Naiver-Stokes Equations** Couette flows, Poiseuille flows, fully developed flows in noncircular cross-sections, Unsteady flows, Creeping flows.	**8**
	Total	**21**
	Section – II	
4	**Potential Flows** Revisit of fluid kinematics, Stream and Velocity potential function, Circulation, Irrotational vortex, Basic plane potential flows: Uniform stream; Source and Sink; Vortex flow, Doublet, Superposition of basic plane potential flows, Flow past a circular cylinder, Magnus effect; Kutta- Joukowski lift theorem; Concept of lift and drag.	**6**

5	**Laminar Boundary Layers** Boundary layer equations, Boundary layer thickness, Boundary layer on a flat plate, similarity solutions, Integral form of boundary layer equations, Approximate Methods, Flow separation, Entry flow into a duct.	**6**
6	**Elements of Stability Theory** Concept of small-disturbance stability, Orr-Sommerfeld equation, Inviscid stability theory, Boundary layer stability, Thermal instability, Transition to turbulence.	**3**
7	**Turbulent Flow** Introduction, Fluctuations and time averaging, General equations of turbulent flow, Turbulent boundary layer equation, Flat plate turbulent boundary layer, Turbulent pipe flow, Prandtl mixing hypothesis, Turbulence modeling, Free turbulent flows.	**6**
	Total	**21**

Instructional Method and Pedagogy:

- Lectures will be conducted with the aid of multi-media projector, blackboard etc.
- Assignments based on course content will be given to the research scholar at the end of each unit/topic and will be evaluated at regular interval.
- Surprise tests/Quizzes/Seminar will be conducted.
- The course includes tutorials, where scholars have an opportunity to practice the examples related to concepts being taught in lectures.

Reference Books/Text book:

1) Frank M. White, Fluid Mechanics, Tata McGraw-Hill,Singapore, Sixth Edition, 2008.
2) Frank M. White, Viscous Fluid Flow, Third Edition,McGraw-Hill Series of Mechanical Engineering, 2006.
3) John D. Anderson Jr, Modern Compressible Flow with Historical Perspective, McGraw-Hill, 1990.
4) Batchelor G.K, An Introduction to Fluid Dynamics,Cambridge University Press, 1983.
5) John D. Anderson Jr., Computational Fluid Dynamics: The Basics with Applications, McGraw-Hill Series of Mechanical Engineering, 1995.

Additional Resources

https://nptel.ac.in/courses/112105218/

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SYLLABUS

Course Title	THERMAL SIMULATION USING LabVIEW
Course Code	TH118
Course Credit	Lecture : 01
	Practical : 01
	Tutorial : 00
	Total : 02

Course Learning Outcomes

After Successful completion of the above course; students will be able to:

- **Develop** graphical programing skill.
- **Simulate** and **Analyze** various thermal system models.

Detailed Syllabus

Sr. No.	Name of chapter & Details	Hours Allotted
	SECTION-I	
1	**Navigating LabVIEW** Introduction to LabVIEW, Project Explorer, Parts of a VI, Front Panel, Block Diagram, Searching for Controls, VIs and Functions, selecting a Tool, Data flow, Building a Simple VI	**02**
2	**Troubleshooting and Debugging VIs** Correcting Broken Vis, Debugging Techniques, Undefined or Unexpected Data, Error Handling	**04***
3	**Implementing a VI** Designing Controls and Indicators, LabVIEW Data Types, Documenting Code, While Loops, For Loops, timing a VI, Data Feedback in Loops, Plotting Data—Waveform Chart, Case Structures	**04***
4	**Developing Modular Applications** Understanding Modularity, Building the Icon and Connector Pane, Using SubVIs.	**01**
5	**Creating and Leveraging Data Structures** Arrays, Common Array Functions, Polymorphism, Auto-Indexing, Clusters, Type Definitions	**02**
6	**Managing File and Hardware Resources** Understanding Hardware and Software Resources, File I/O, Acquiring	**04***

	Measurements with a DAQ System, Controlling Instruments	
7	**Using Sequential and State Machine Algorithms** Using Sequential Programming, Using State Programming, State Machines	**02**
8	**Solving Dataflow Challenges with Variables** Communicating Between Parallel Loops, Writing to Controls and Reading from Indicators, Variables, Race Conditions	**04***
	Total	**07**
	SECTION-II	
9	**Moving Beyond Dataflow** Asynchronous Communication, Queues, Event-Driven Programming	**02**
10	**Implementing Design Patterns** Design Patterns, Simple Design Patterns, Multiple Loop Design Patterns, Error Handlers, Generating Error Codes and Messages, Timing a Design Pattern, Functional Global Variable Design Pattern	**04***
11	**Controlling the User Interface** VI Server Architecture, Property Nodes, Invoke Nodes , Control References	**04**
12	**File I/O Techniques** Compare File Formats, Create File and Folder Paths, Write and Read Binary Files, Work with Multichannel Text Files and Headers, Access TDMS Files in LabVIEW and Excel	**04***
13	**Improving an Existing VI** Refactoring Inherited Code, Typical Refactoring Issues, Refactoring Checklist	**04***
14	**Creating and Distributing Applications** Preparing the Files, Build Specifications, Create and Debug an Application, Create an Installer, Summary	**01**
	Total	**07**

Instructional Method and Pedagogy:

- Laboratory will be conducted with the aid of multi-media projector, black board, transparencies etc.
- Assignments and exercise will be given to the students for each unit/topic and will be evaluated at regular interval.
- Surprise tests/Quizzes/Seminar/Tutorials will be conducted.
- * Topics will be covered in lab hours.

Resources

http://www.ni.com/en-in.html

Course Title	SOFTWARE LAB - I
Course Code	PG101
Course Credit	Theory :00
	Practical :01
	Tutorial :00
	Credits :01

Course Learning Outcomes:

After Successful completion of the above course, students will be able to:

- **Select** an optimum programming method, command and process to identify, formulate, and solve engineering problems.
- **Demonstrate** the significance of MATLAB.
- **Apply** knowledge of mathematics science and engineering to design and analyze various mechanical engineering systems.
- **Use** the techniques, skills and modern engineering tools necessary for design engineering practice.

Detailed Syllabus

Sr. No.	Name of chapter & details	Hours Allotted
	SECTION-I	
1.	**MATLAB Basics** MATLAB Windows, Data Input and Output, Arithmetic Algebra, Symbolic Expressions, Arithmetic Managing Variables, Errors in Input, Vectors and Matrices.	6
2.	**Interacting with MATLAB** The MATLAB Interface, The Desktop, Menu and Tool Bars, The Workspace, The Working Directory, Command Window, M-Files, Script M-Files, Function M-Files, Variables in Script M-Files, Variables in Function M-Files, Structure of Function M-Files, Loops, Diary Files.	8
3.	**MATLAB Programming** Branching with if, switch, for, while etc., Open-Ended Loops, breaking from a Loop, Other Programming Commands, Sub functions, Commands for Parsing Input and Output, User Input and Screen Output, Evaluation, Debugging, Interacting with the Operating System, Calling External Programs, File Input and Output.	8
4.	**MATLAB Graphics** Two-Dimensional Plots, Parametric Plots, Contour Plots and Implicit Plots, Field Plots, Three-Dimensional Plots, Curves in Three-Dimensional Space,	6

	Surfaces in Three-Dimensional Space, Special Effects, Combining Figures in One Window Animations, Customizing and Manipulating Graphics, Change of Viewpoint, Change of Plot Style, Full-Fledged Customization, Quick Plot Editing in the Figure Window	
	Total hours	**28**

Instructional method and Pedagogy:

- At the commencement of the course, the course delivery pattern, course goal, prerequisite of the course etc. will be discussed.
- Laboratories will be conducted with the aid of multi-media projector, black board, activity kit, design and analysis software MATLAB.
- Assignments, based on course content, will be given to the students at the end of each unit/topic and will be evaluated at regular interval.
- Attendance is compulsory in laboratory.
- The course includes a laboratory, where students have an opportunity to build appreciations.

Reference Books:

1. Pratap Rudra p, Getting Started with MATLAB 7: A Quick Introduction for Scientists and Engineers, Oxford University Press New York
2. Raj Kumar Bansal, MATLAB and its Application in Engineering
3. Chapra Steven, Applied Numerical Methods: With Matlab for Engineers and Scientists, Tata McGraw-Hill Publishing Company Limited New Delhi

Additional Resources

- http://www.mathworks.com/help/pdf_doc/matlab/getstart.pdf
- http://www.mathworks.com/help/matlab/
- http://www.tutorialspoint.com/matlab/index.htm

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SYLLABUS

Course Title	THEORY AND DESIGN OF CRYOGENIC SYSTEMS (ELECTIVE –I)
Course Code	TH923
Course Credit	Lecture : 03
	Practical : 01
	Tutorial : 00
	Total : 04

Course Learning Outcomes

After Successful completion of the above course; students will be able to:

- **Familiarize** the students behind the latest topics of cryogenics in which the study of the production of very low temperature (below −150 °C, −238 °F or 123 K) and the behavior of materials at those temperatures is considered.
- **Familiar** with the industrial applications of cryogenic systems for the production of liquefied gases like nitrogen, helium and air.
- **Study** the working, construction and operation of different cryogenic cycles like joule-thomson, Gifford-mcmohan, sterling etc.
- **Study** the specialized design of heat exchangers and regenerators used in cryogenic application.
- **Study** the storage, handling and transportation system for cryogenic fluids.
- **Study** the importance of lockhardt-martinelli correlations for pressure drop-in two-phase fluid systems.

Detailed Syllabus

Sr. No.	Name of chapter & Details	Hours Allotted
	SECTION-I	
1	**Introduction and application:**	2
2	**Cryogenics Fluids:** • Properties of air, Oxygen, Nitrogen, Hydrogen, Helium and its isotopes.	3
3	**Cryogenics refrigeration systems:** • Recuperative & regenerative cycles, Joule Thomson cycle; • Gifford, Mcmohan cycle, Stirling cycle, Pulse Tube refrigeration, Magneto caloric refrigeration, • Vuilleumier refrigerator.	5
4	**Gas liquefaction systems:** • Ideal systems, Linde dual pressure system, Claude, Heylandt, Kapitza systems, Cascade cycle.	4

	Cryogenic insulation: • Vacuum insulation, Multilayer insulation (MLI). • Methods of measuring effective thermal conductivity of MLI, Liquid &vapour shield. • Evacuated porous insulation, Gas filled powders and fibrous materials, Solid foams.	**3**
6	**Cryogenic instrumentation:** • Peculiarities of cryogenic strain measurement, Pressure, Flow. • Density, Temperature and liquid level measurement for cryogenic application.	**4**
	Total	**21**
	SECTION-II	
7	**Purification and separation of gases Liquefied natural gas:** • Principles of gas separation. • Separation by condensation & flashing, Separation by distillation. • Air separation system: Linde single column system. Linde double, Column systems etc., Liquefaction of Natural Gas.	**5**
8	**Storage & handling systems:** • Dewar vessel design, Piping, Support systems, Vessel safety devices and storage systems, Industrial storage systems.	**3**
9	**Transfer systems:** • Transfer from storage, Un-insulated transfer lines, Insulated lines, Transfer system components.	**4**
10	**Properties and selection of Materials:** • Study of material properties. • Their selection for cryogenic application.	**4**
11	**Vacuum Systems, Cryo pumping:**	**2**
12	**Equipment for low temperature systems:** • Heat exchangers, Compressor, Expanders.	**3**
	Total	**21**

Instructional Method and Pedagogy:

- At the beginning of course, the course delivery pattern, prerequisite of the subject will be discussed.
- Lectures will be conducted with the aid of multi-media projector, blackboard, OHP etc.
- Attendance is compulsory in lectures and laboratory.
- Minimum two internal exams will be conducted and average of two will be considered as a part of overall evaluation.
- Assignments based on course content will be given to the students at the end of each unit/topic and will be evaluated at regularly.
- Surprise tests/Quizzes/Seminar/Tutorials will be conducted.
- The course includes a laboratory, where students have an opportunity to build an appreciation for the concepts being taught in lectures.
- Tutorials and assignments are to be submitted as term-work in laboratory related to course contents.

Reference Books:

1. Hastlden, C., “Cryogenic Fundamentals”, Academic Press, 2001.
2. Barron R., “Cryogenic Systems”, Plenum Press, 2001.
3. Walker, “Cryocoolers”, Vol. 1 & 2, Plenum Press, 2000.
4. Mikulin, Y., “Theory and Design of Cryogenic systems”, MIR Publication, 2002.
5. Barron, R. F., “Cryogenics Systems”, Oxford Press., USA, 2002.

RK.UNIVERSITY

SYLLABUS

Course Title	**ANALYSIS AND DESIGN OF I.C. ENGINES (ELECTIVE –I)**
Course Code	**TH924**
Course Credit	Lecture : 03
	Practical : 01
	Tutorial : 00
	Total : 04

Course Learning Outcomes

After Successful completion of the above course; students will be able to:

- **Understand** and **analyze** the working of the entire cycle of I.C engines.
- **Model** and **simulate** the engine cycle.
- **Understand** and **apply** the advanced concepts of supercharger, turbocharger, balancing and vibrations in the working of I.C engines, hereby built a platform to pursue their further research work.

Detailed Syllabus

Sr. No.	Name of chapter & Details	Hours Allotted
	SECTION-I	
1	**Review of thermodynamic cycles – ideal, fuel – air and real cycles:**	**6**
2	**Engine heat transfer and friction:**	**6**
3	**Gas exchange processes:** • Flow through valves, phase of the flow, turbulence, • Analysis of suction and exhaust processes, manifold tuning.	**6**
4	**Digital simulation of complete engine cycle:**	**3**
	Total	**21**
	SECTION-II	
5	**Analysis of compression and expansion processes:**	**5**
6	**Modeling of combustion in S.I. and C.I. engines:**	**5**
7	**Design of engine components:** • piston, cylinder, piston rings, connecting rod, crankshaft etc.	**5**
8	**Theory of super chargers / turbo chargers:**	**3**
9	**Similarity considerations, balancing and vibrations of engines:**	**3**
	Total	**21**

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- The course includes a laboratory, where students have an opportunity to build an appreciation for the concepts being taught in lectures.
- Tutorials and assignments are to be submitted as term-work in laboratory related to course contents.

Reference Books:

1. Maleev, "I. C. Engines: Theory and Practice", McGraw -Hill-2000.
2. Heywood, J. B., "Internal Combustion Engine Fundamentals", McGraw Hill International Edition, 2002.
3. Richard, Stone, "Introduction to Internal Combustion Engines", 2nd Edn. McMillan Press, 2003.
4. Taylor, C. F., "Internal Combustion Engine in Theory and Practice", Vol. 1 & 2, M. I. T. Press,
   Cambridge, USA, 2003.
5. Juvinall, R. C., and Marshek, K. M., "Fundamental of Machine Component Design", John Wiley & Sons, N.Y., 2001.

Course Title	SOLAR ENERGY CONVERSION SYSTEMS (ELECTIVE –I)
Course Code	TH925
Course Credit	Lecture : 03
	Practical : 01
	Tutorial : 00
	Total : 04

Course Learning Outcomes

After Successful completion of the above course, students will be able to:

- **Importance** of solar energy resources for the present energy scenario.
- **Pursue** further research work behind the development of solar energy sources as a part of their research work.
- **Familiarize** the students with the importance of the solar energy sources and make them motivate towards further research in the same field as far as the crises in the conventional sector are considered.
- **Understand** the solar energy aspects in detail as it is one of the prime and most important sources of non-conventional energy hereby the study of various solar angles in particular and based on this criteria the design and analysis of solar concentrators and collectors.

Detailed Syllabus

Sr. No.	Name of chapter & Details	Hours Allotted
	SECTION-I	
1	**Energy scenario and overview of thermal application of solar energy:** • Production and reserves of commercial energy sources- world and Indian scenario • Energy alternatives for India and importance of Solar Energy, Advantages and Dis-advantages of Solar energy. • Devices for thermal collection and storage. • Thermal applications of solar energy.	**07**
2	**Solar radiation:** • Solar radiation outside earth's atmosphere and on earth surface. • Fundamental terminology, Declination angle and Day length calculations. • Instruments for measuring solar radiation and sunshine, solar radiation data and geometry, relations for predicting the availability of solar radiation. Solar radiation on tilted surface.	**07**

3	**Liquid flat plate collectors:** • Performance analysis of collectors, transmissivity, absorptivity, efficiency, effect of various parameters on performance, transient analysis. • Testing procedures. • Solar Coatings0	**07**
	Total	**21**
	SECTION-II	
4	**Concentrating collectors:** • Flat plate collectors with plane reflectors. • Cylindrical parabolic collectors, compound parabolic collectors, paraboloid dish collectors, central receiver collector.	**10**
5	**Thermal energy storage:** • Sensible heat storage, latent heat storage, thermochemical storage. • Solar pond: performance analysis, experimental studies, operational problems.	**08**
5	**Methods of solar power generation:** • Indirect Route: Thermal conversion • Direct route: Photovoltaic conversion, features and applications of same	**03**
	Total	**21**

Instructional Method and Pedagogy:

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- Tutorials and assignments are to be submitted as term-work in laboratory related to course contents.

Reference Books:

1. Non-conventional energy sources by G.D. Rai, Khanna Publishers.
2. Solar Energy: Fundamentals and Applications by H. P. Garg& Jai Prakash, TMH.
3. Solar Energy: Principles of Thermal Collection and Storage by S. P. Sukhatme, TMH.
4. Alternative Energy Sources by B. L. Singhal, Tech Max Publication.
5. Non-Conventional Energy Resources by S.HasanSaeed and D. K. Sharma.
6. Solar Engineering of Thermal Processes by Duffic and Beckman, John Wiley.