ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES
(AUTONOMOUS)
UTUKUR (P), C. K. DINNE (V&M), KADAPA, YSR DIST.
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# M.TECH. IN THERMAL ENGINEERING
# COURSE STRUCTURE & SYLLABI

## SEMSTER - III

| S.No. | Course codes | Course Name | Category | Hours per week | | | Credits |
|---|---|---|---|---|---|---|---|
| | | | | L | T | P | |
| **1.** | 23HPE8813<br>23HPE8814<br>23HPE8815 | **Program Elective Course – V**<br>Optimization Techniques & Its Applications<br>Jet Propulsion & Rocketry<br>Aircraft and Space Propulsion | PE | 3 | 0 | 0 | 3 |
| **2.** | 23HOE1E01<br>23HOE0502<br>23HOE0303 | **Open Elective**<br>Business Analytics<br>Internet of Things<br>Mechatronics | OE | 3 | 0 | 0 | 3 |
| **3.** | 23HPR8801 | Dissertation Phase – I | PR | 0 | 0 | 20 | 10 |
| **4.** | 23HCA8801 | Co-curricular Activities | | | | | 2 |
| | | **Total** | | | | | **18** |

## SEMESTER - IV

| S.No. | Course codes | Course Name | Category | Hours per week | | | Credits |
|---|---|---|---|---|---|---|---|
| | | | | L | T | P | |
| **1.** | 23HPR8802 | Dissertation Phase – II | PR | 0 | 0 | 32 | 16 |
| | | **Total** | | | | | **16** |

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| Course Code | OPTIMIZATION TECHNIQUES & ITS APPLICATIONS<br>Program Elective Course - V | L | T | P | C |
|---|---|---|---|---|---|
| 23HPE8813 | | 3 | 0 | 0 | 3 |
| | Semester | III | | | |

**Course Objectives:** Student will be able

- To introduce the fundamental concepts of Optimization Techniques;
- To provide the concepts of various classical and modern methods of for constrained and unconstrained problems in both single and multivariable.
- To make the learners aware of the importance of optimizations in real sceneries

**Course Outcomes: -**

- Formulate optimization problems
- Understand and apply the concept of optimality criteria for various type of optimization problems;
- Solve various constrained and unconstrained problems in single variable as well as multivariable;

| UNIT – I | | Lecture Hrs:9 |
|---|---|---|

**Introduction**: Engineering Applications of optimization- statement of an optimization problem – Classification of optimization problems.
**Single Variable Non-Linear Unconstrained Optimization:** One dimensional Optimization methods: - Uni- modal function, elimination methods, Fibonacci method, golden section method, interpolation methods – quadratic and cubic interpolation methods.

| UNIT – II | | Lecture Hrs:9 |
|---|---|---|

**Multi variable non-linear unconstrained optimization:** Direct search method – Univariant method - pattern search methods – Powell's- Hook -Jeeves, Rosenbrock search methods- gradient methods, gradient of function, steepest decent method, Fletcher Reeves method, variable metric method.

**Linear Programming** – Graphical Method-Simplex method- Dual simplex method-Revised simplex method- Parametric linear programming- Goal Programming Simulation- types of simulations- Applications of simulations to inventory, queuing and thermal systems

| UNIT – III | | Lecture Hrs:9 |
|---|---|---|

**Integer Programming-** Introduction – formulation – Geometry cutting plane algorithm – Zero or one algorithm, branch and bound method
**Stochastic Programming**: Basic concepts of probability theory, random variables- distributions-mean, variance, correlation, co variance, joint probability distribution- stochastic linear, dynamic programming.

| UNIT – IV | | Lecture Hrs:9 |
|---|---|---|

**Geometric Programming:** Polynomials – arithmetic - geometric inequality – unconstrained G.P- constrained G.P.

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| UNIT – V | | Lecture Hrs:9 |
|---|---|---|
| **Non Traditional Optimization Algorithms:** Genetics Algorithm-Working Principles, Similarities and Differences between Genetic Algorithm and Traditional Methods. Simulated Annealing- Working Principle-Simple Problems. Application in production problems. | | |
| **Textbooks:** | | |
| 1. Optimization theory and Applications,S.S.Rao,New Age International.<br>2. Optimization for Engineering Design, Kalyanmoy Deb, PHI | | |
| **Reference Books:** | | |
| 1. Operations Research, S.D.Sharma,<br>2. Operation Research, H.A.Taha ,TMH<br>3. Optimization in operations research, R.LRardin<br>4. Optimization Techniques, Belagundu & Chandraputla, Pearson Asia.<br>5. Optimization Techniques theory and practice, M.C.Joshi, K.M.Moudgalya, Narosa Publications | | |

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| Course Code | JET PROPULSION & ROCKETRY | L | T | P | C |
|---|---|---|---|---|---|
| 23HPE8814 | Program Elective Course - V | 3 | 0 | 0 | 3 |
| | Semester | III | | | |

**Course Objectives:** Student will be able to

- Analyze thermodynamics of an aircraft jet engine and calculate the performance measures, such as thrust and specific fuel consumption in terms of design requirement.
- Be able to estimate the best possible engine performance as a function of principal design parameters, such as maximum engine temperature, pressure ratio, and flight speed
- Analyze the internal mechanisms of gas turbine engine components and understand the factors that limit the practical performance of inlets, combustion chambers, and nozzles

**Course Outcomes: -** Student will be able to

- Understand the operating characteristics of compressors and turbines in terms of given blade shapes, angles, and direction of rotation
- Design a gas turbine engine using the understanding of the relationship between components, at least at the level of selecting the number of spools and stages
- Understand the broader context of aircraft propulsion technology, including the environmental and economic issues

| UNIT – I | | Lecture Hrs:9 |
|---|---|---|

**Turbo Jet Propulsion System:** Gas turbine cycle analysis – layout of turbo jet engine. Turbo machinery-compressors and turbines, combustor, blade aerodynamics, engine off design performance analysis.

**Flight Performance:** Forces acting on vehicle – Basic relations of motion – multi stage vehicles.
**Principles of Jet Propulsion and Rocketry:** Fundamentals of jet propulsion, Rockets and air breathing jet engines – Classification – turbo jet, turbo fan, turbo propulsion, rocket (Solid and Liquid propellant rockets) and Ramjet engines.

| UNIT – II | | Lecture Hrs:9 |
|---|---|---|

**Nozzle:** Theory and Characteristics and Parameters**:** Theory of one dimensional convergent – divergent nozzles – aerodynamic choking of nozzles and mass flow through a nozzle – nozzle exhaust velocity – thrust, thrust coefficient, Ac / At of a nozzle, Supersonic nozzle shape, non-adapted nozzles, summer field criteria, departure from simple analysis – characteristic parameters

1) characteristic velocity, 2) specific impulse 3) total impulse 4) relationship between the characteristic parameters 5) nozzle efficiency, combustion efficiency and overall efficiency.

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| | | |
|---|---|---|
| **UNIT – III** | | Lecture Hrs:9 |

**Aero Thermo Chemistry of The Combustion Products:** Review of properties of mixture of gases – Gibbs – Dalton laws – Equivalent ratio, enthalpy changes in reactions, heat of reaction and heat of formation – calculation of adiabatic flame temperature and specific impulse – frozen and equilibrium flows.
**Solid Propulsion System:** Solid propellants – classification, homogeneous and heterogeneous propellants, double base propellant compositions and manufacturing methods. Composite propellant oxidizers and binders. Effect of binder on propellant properties. Burning rate and burning rate laws, factors influencing the burning rate, methods of determining burning rates

| | | |
|---|---|---|
| **UNIT – IV** | | Lecture Hrs:9 |

Solid propellant rocket engine – internal ballistics, equilibrium motor operation and equilibrium pressure to various parameters. Transient and pseudo equilibrium operation, end burning and burning grains, grain design. Rocket motor hard ware design. Heat
transfer considerations in solid rocket motor design. Ignition system, simple pyro devices.
**Liquid Rocket Propulsion System:** Liquid propellants – classification, Mono and Bi propellants, Cryogenic and storage propellants, ignition delay of hypergolic propellants, physical and chemical characteristics of liquid propellant. Liquid propellant rocket engine – system layout, pump and pressure feed systems, feed system components. Design of combustion chamber, characteristic length, constructional features, and chamber wall stresses. Heat transfer and cooling aspects. Uncooled engines, injectors – various types, injection patterns, injector characteristics, and atomization and drop size distribution, propellant tank design.

| | | |
|---|---|---|
| **UNIT – V** | | Lecture Hrs:9 |

**Ramjet and Integral Rocket Ramjet Propulsion System:** Fuel rich solid propellants, gross thrust, gross thrust coefficient, combustion efficiency of ramjet engine, air intakes and their classification – critical, super critical and sub-critical operation of air intakes, engine intake matching, classification and comparison of IIRR propulsion systems.

**Textbooks:**

1. Mechanics and Dynamics of Propulsion, Hill and Peterson
2. Rocket propulsion elements, Sutton

**Reference Books:**

1. Gas Turbines, Ganesan (TMH)
2. Gas Turbines and Propulsive Systems, Khajuria & Dubey (Dhanpatrai)
3. Rocket propulsion, Bevere
4. Jet propulsion, Nicholas Cumpsty

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| Course Code | AIR CRAFT AND SPACE PROPULSION | L | T | P | C |
|---|---|---|---|---|---|
| 23HPE8815 | Program Elective Course - V | 3 | 0 | 0 | 3 |
| | Semester | III | | | |

**Course Objectives:** Student will be able to

- Gain insight on the working principle of rocket engines, different feed systems, propellants and their properties and dynamics of rockets.

**Course Outcomes: -** Student will be able to

Understand the working of different types of aircraft and rocket propulsion systems and their performance characteristics.

| UNIT – I | | Lecture Hrs:9 |
|---|---|---|

**GAS DYNAMICS**

Wave motion - Compressible fluid flow through variable area devices – Stagnation state Mach Number and its influence and properties, Isentropic Flow, Rayleigh and Fanno Flow. Deflagration and Detonation – Normal shock and oblique shock waves.

| UNIT – II | | Lecture Hrs:9 |
|---|---|---|

**THERMODYNAMICS OF AIRCRAFT ENGINES**

Theory of Aircraft propulsion – Thrust – Various efficiencies – Different propulsion systems – Turboprop – Ram Jet – Turbojet, Turbojet with after burner, Turbo fan and Turbo shaft. Variable thrust-nozzles – vector control.

| UNIT – III | | Lecture Hrs:9 |
|---|---|---|

**PERFORMANCE CHARACTERISTICS OF AIRCRAFT ENGINES**

Engine - Aircraft matching – Design of inlets and nozzles – Performance characteristics of Ramjet, Turbojet, Scramjet and Turbofan engines.

| UNIT – IV | | Lecture Hrs:9 |
|---|---|---|

**ROCKET PROPULSION**

Theory of rocket propulsion – Rocket equations – Escape and Orbital velocity – Multi-staging of Rockets – Space missions – Performance characteristics – Losses and efficiencies

| UNIT – V | | Lecture Hrs:9 |
|---|---|---|

**ROCKET THRUST CHAMBER**

Combustion in solid and liquid propellant classification – rockets of propellants and Propellant Injection systems – Non-equilibrium expansion and supersonic combustion – Propellant feed systems – Reaction Control Systems - Rocket heat transfer.

**Textbooks:**

1. Philip G. Hill and Carl R. Peterson, Mechanics and Thermodynamics of Propulsion, Second
2. Edition, Addition – Wesley Publishing Company, New York, 2009.
3. Zucrow N.J. Principles of Jet Propulsion and Gas Turbines, John Wiley and Sons New York, 1970

**Reference Books:**

1. Zucrow N.J. Aircraft and Missile Propulsion, Vol. I and Vol. II, John Wiley and Sons Inc, New York, 1975.
2. S. M.Yahya, Fundamentals of Compressible Flow. Third edition, New Age International Pvt Ltd, 2003.
3. Bonney E.A. Zucrow N.J. Principles of Guided Missile Design, Van Nostranc Co., 1956.

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| Course Code | BUSINESS ANALYTICS | L | T | P | C |
|---|---|---|---|---|---|
| 23HOE1E01 | | 3 | 0 | 0 | 3 |
| | Semester | III | | | |

**Course Objectives:**

- The main objective of this course is to give the student a comprehensive understanding of
- business analytics methods.

**Course Outcomes (CO): Student will be able to**

- Students will demonstrate knowledge of data analytics.
- Students will demonstrate the ability of think critically in making decisions based on
- data and deep analytics.
- Students will demonstrate the ability to use technical skills in predicative and
- prescriptive modeling to support business decision-making.
- Students will demonstrate the ability to translate data into clear, actionable insights.

| UNIT - I | | Lecture Hrs:09 |
|---|---|---|

Business Analysis: Overview of Business Analysis, Overview of Requirements, Role of the Business Analyst.
Stakeholders: the project team, management, and the front line, Handling Stakeholder Conflicts.

| UNIT - II | | Lecture Hrs:09 |
|---|---|---|

Life Cycles: Systems Development Life Cycles, Project Life Cycles, Product Life Cycles, Requirement Life Cycles.

| UNIT - III | | Lecture Hrs:09 |
|---|---|---|

Forming Requirements: Overview of Requirements, Attributes of Good Requirements, Types of Requirements, Requirement Sources, Gathering Requirements from Stakeholders, Common Requirements Documents. Transforming Requirements: Stakeholder Needs Analysis, Decomposition Analysis, Additive/Subtractive Analysis, Gap Analysis, Notations (UML & BPMN), Flowcharts, Swim Lane Flowcharts, Entity-Relationship Diagrams, State-Transition Diagrams, Data Flow Diagrams, Use Case Modeling, Business Process Modeling

| UNIT - IV | | Lecture Hrs:09 |
|---|---|---|

Finalizing Requirements: Presenting Requirements, Socializing Requirements and Gaining Acceptance, Prioritizing Requirements. Managing Requirements Assets: Change Control, Requirements Tools

| UNIT - V | | Lecture Hrs:09 |
|---|---|---|

Recent Trends in: Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data Journalism.

**Textbooks:**

1. Business Analysis by James Cadle et al.
2. Project Management: The Managerial Process by Erik Larson and, Clifford Gray

Reference Books:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

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| Course Code | INTERNET OF THINGS (IOT) | L | T | P | C |
|---|---|---|---|---|---|
| 23HOE0502 | | 3 | - | - | 3 |
| | Semester | III | | | |

**Course Objectives: Student will be able**

- To study fundamental concepts of IoT
- To understand roles of sensors in IoT
- To Learn different protocols used for IoT design

**Course Outcomes (CO): Student will be able to**

- Understand the various concepts, terminologies and architecture of IoT systems.
- Use sensors and actuators for design of IoT.
- Understand and apply various protocols for design of IoT systems

| UNIT – I | Lecture Hrs:09 |
|---|---|

Fundamentals of IoT: Introduction, Definitions & Characteristics of IoT, IoT Architectures, Physical & Logical Design of IoT, Enabling Technologies in IoT, History of IoT, About Things in IoT, The Identifiers in IoT, About the Internet in IoT, IoT frameworks, IoT and M2M

| UNIT – II | Lecture Hrs: 09 |
|---|---|

Sensors Networks: Definition, Types of Sensors, Types of Actuators, Examples and Working, IoT Development Boards: Arduino IDE and Board Types, RaspberriPi Development Kit, RFID Principles and components, Wireless Sensor Networks: History and Context, The node, Connecting nodes, Networking Nodes, WSN and IoT.

| UNIT – III | Lecture Hrs: 09 |
|---|---|

Wireless Technologies for IoT: WPAN Technologies for IoT: IEEE 802.15.4, Zigbee, HART, NFC, Z-Wave, BLE, Bacnet, Modbus.
IP Based Protocols for IoT IPv6, 6LowPAN, RPL, REST, AMPQ, CoAP, MQTT. Edge connectivity and protocols

| UNIT – IV | Lecture Hrs: 09 |
|---|---|

Data Handling& Analytics: Introduction, Bigdata, Types of data, Characteristics of Big data, Data handling Technologies, Flow of data, Data acquisition, Data Storage, Introduction to Hadoop. Introduction to data Analytics, Types of Data analytics, Local Analytics, Cloud analytics and applications

| UNIT - V | Lecture Hrs: 09 |
|---|---|

Applications of IoT: Home Automation, Smart Cities, Energy, Retail Management, Logistics, Agriculture, Health and Lifestyle, Industrial IoT, Legal challenges, IoT design Ethics, IoT in Environmental Protection.

**Textbooks:**

1. Hakima Chaouchi, — "The Internet of Things Connecting Objects to the Web" ISBN : 978-1-84821-140-7, Wiley Publications
2. Olivier Hersent, David Boswarthick, and Omar Elloumi, — "The Internet of Things: Key Applications and Protocols", WileyPublications
3. Vijay Madisetti and ArshdeepBahga, — "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014.

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| Course Code | MECHATRONICS | L | T | P | C |
|---|---|---|---|---|---|
| 23HOE0303 | | 3 | 0 | 0 | 3 |
| | Semester | III | | | |

**Course Objectives:** Student will be able

- To study fundamental concepts of Signal condition
- To understand the concepts of precision mechanical systems
- To Learn different electronic interface subsystems

**Course Outcomes (CO):** Student will be able to

- Understand the various concepts, terminologies of Signal condition
- Understand the basics electronic interface subsystems
- Understand and apply various precision mechanical systems
- Understand various applications of microcontrollers overview
- Understand the controlling of programmable logic and programmable motion.

| UNIT – I | Lecture Hrs:09 |
|---|---|

**INTRODUCTION:** Definition – Trends - Control Methods: Standalone, PC Based (Real Time Operating Systems, Graphical User Interface, Simulation) - Applications: SPM, Robot, CNC, FMS, CIM.

**SIGNAL CONDITIONING: I**ntroduction – Hardware - Digital I/O, Analog input – ADC, resolution, speed channels Filtering Noise using passive components – Resistors, capacitors - Amplifying signals using OP amps – Software - Digital Signal Processing – Low pass, high pass, notch filtering.

| UNIT – II | Lecture Hrs: 09 |
|---|---|

**PRECISION MECHANICAL SYSTEMS:** Pneumatic Actuation Systems - Electro-pneumatic Actuation Systems - Hydraulic Actuation Systems - Electro-hydraulic Actuation Systems - Timing Belts – Ball Screw and Nut - Linear Motion Guides - Linear Bearings - Harmonic Transmission - Bearings- Motor / Drive Selection.

| UNIT – III | Lecture Hrs: 09 |
|---|---|

**ELECTRONIC INTERFACE SUBSYSTEMS:** TTL, CMOS interfacing - Sensor interfacing – Actuator interfacing – solenoids, motors Isoation schemes- opto coupling, buffer IC's - Protection schemes – circuit breakers, over current sensing, resetable fuses, thermal dissipation - Power Supply - Bipolar transistors / mosfets

**ELECTROMECHANICAL DRIVES:** Relays and Solenoids - Stepper Motors - DC brushed motors – DC brushless motors - DC servo motors - 4-quadrant servo drives, PWM's - Pulse Width Modulation – Variable Frequency Drives, Vector Drives - Drive System load calculation

| UNIT – IV | Lecture Hrs: 09 |
|---|---|

**MICROCONTROLLERS OVERVIEW**: 8051 Microcontroller, microp rocessor structure – Digital Interfacing - Analog Interfacing - Digital to Analog Convertors - Analog to Digital Convertors - Applications. Programming –Assembly, C (LED Blinking, Voltage measurement using ADC).

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|---|---|---|

**PROGRAMMABLE LOGIC CONTROLLERS:** Basic Structure - Programming: Ladder diagram -Timers, Internal Relays and Counters - Shift Registers - Master and Jump Controls - Data Handling - Analog input / output - PLC Selection - Application.

**PROGRAMMABLE MOTION CONTROLLERS:** Introduction - System Transfer Function – Laplace transform and its application in analysing differential equation of a control system - Feedback Devices: Position, Velocity Sensors - Optical Incremental encoders - Proximity Sensors: Inductive, Capacitive,

**Textbooks:**

1. A text book of Mechatronics by Er.R.K. RAJPUT., S. CHAND publications
2. A text book of Mechatronics by Nitalgour Premchand Mahalik., McGraw Hill publications

**Reference Books:**

1. A text book of Mechatronics by W.Bolton ., Pearson Publications

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