St. XAVIER'S CATHOLIC COLLEGE OF ENGINEERING

Chunkankadai, Nagercoil – 629 003.

AUTONOMOUS COLLEGE AFFILIATED TO ANNA UNIVERSITY

ACADEMIC REGULATIONS 2022

Department of Mechanical Engineering

Open Electives Available for Students from Other Departments

Open Elective-1

Sl. No.	Course code	Course title	Categ-ory	Periods Per week			Total contact periods	Credits
				L	T	P		
1.	ME22681	Nanomaterials	OEC -1	3	0	0	3	3
2.	ME22682	Energy Technology	OEC -2	3	0	0	3	3

Open Elective - II

Sl. No.	Course code	Course title	Categ-ory	Periods Per week			Total contact periods	Credits
				L	T	P		
3.	ME22781	Additive Manufacturing	OEC -3	3	0	0	3	3
4.	ME22782	Elements of Marine Engineering	OEC -4	3	0	0	3	3

Open Elective - III

Sl. No.	Course code	Course title	Categ-ory	Periods Per week			Total contact periods	Credits
				L	T	P		
5.	ME22783	Composite Materials	OEC -5	3	0	0	3	3
6.	ME22784	Production Management	OEC -6	3	0	0	3	3

ME22681	NANOMATERIALS	L	T	P	C
		3	0	0	3

Course Objectives

- Understanding the evolution of nanomaterials in the scientific era and make them to understand different types of nanomaterials for the future engineering applications
- Understand the different types of nano material synthesis
- Gaining knowledge on dimensionality effects on different properties of nanomaterials
- Getting acquainted with the different processing techniques employed for fabricating nanomaterials
- Having knowledge on the different characterisation techniques employed to characterise the nanomaterial

UNIT – I INTRODUCTION **9**

Classification: 0D, 1D, 2D, 3D nanomaterials and nano-composites, their mechanical, electrical, optical, magnetic properties; Nanomaterials versus bulk materials. Applications of nanoparticles.

UNIT – II SYNTHESIS OF NANOMATERIALS **9**

Bottom up and Top-down approach for obtaining nano materials - Precipitation methods – sol gel technique – high energy ball milling, CVD and PVD methods, gas phase condensation, magnetron sputtering and laser deposition methods – laser ablation, sputtering.

UNIT – III THERMODYNAMICS & KINETICS OF NANOSTRUCTURED MATERIALS **9**

Size and interface/interphase effects, interfacial thermodynamics, phase diagrams, diffusivity, grain growth, and thermal stability of nanomaterials.

UNIT – IV PROCESSING **9**

Bottom-up and top-down approaches for the synthesis of nanomaterials, mechanical alloying, chemical routes, severe plastic deformation, and electrical wire explosion technique.

UNIT – V STRUCTURAL CHARACTERISTICS **9**

Principles of emerging nanoscale X-ray techniques such as small angle X-ray scattering and X-ray absorption fine structure (XAFS), electron and neutron diffraction techniques and their application to nanomaterials; SPM, Nanoindentation, Grain size, phase formation, texture, stress analysis.

Total: 45 periods

OUTCOMES: At the end of the course the students would be able to

1. Describe the basics of nanomaterial's and its different types with applications.
2. Illustrate the different types of methods to synthesize the nanomaterial.
3. Recognize the effects of dimensionality of materials on the properties.
4. Classify different methods for synthesis of nanomaterials that can be used in engineering applications
5. Choose an appropriate technique for characterizing nanomaterials

Textbooks:

1. William A Goddard "Handbook of Nanoscience, Engineering and Technology", Third Edition, CRC Taylor and Francis group 2012.
2. Bhusan, Bharat, "Handbook of Nanotechnology", Third Edition, Springer 2010.

References:

1. Ivor Brodie and Julius J. Muray, 'The physics of Micro/Nano – Fabrication', Springer International edition, 2010
2. Zehetbauer M.J. and Zhu Y.T., Bulk Nanostructured Materials, Wiley, 2010.
3. M. N. Borah, S. Chaliha, A. Puzari & S. Dutta, "Nano Materials & Applications" Mahaveer Publications, 2022
4. Gutkin Y., Ovid'ko I.A. and Gutkin M., Plastic Deformation in Nanocrystalline Materials, Springer 2010.
5. Thomas Varghese & K.M. Balakrishna "Nanotechnology: An Introduction To Synthesis, Properties And Applications of Nanomaterials" Atlantic Publishers and Distributors (P) Ltd, 2024

COs	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	2	3	-	-	-	-	-	-	-	-			
CO2	3	1	2	2	-	-	-	-	-	-	-	-			
CO3	3	2	1	2	-	-	-	-	-	-	-	-			
CO4	3	1	-	2	-	-	-	-	-	-	-	-			
CO5	3	2	2	2	-	-	-	-	-	-	-	-			
CO	3	2	2	2	-	-	-	-	-	-	-	-			

ME22682 ENERGY TECHNOLOGY

L	T	P	C
3	0	0	3

Course Objectives

- To study about the various energy resources available including renewable energy.
- To study about the conventional energy sources.
- To study about the unconventional energy sources.
- To learn renewable energy technologies and the basics of biomass energy
- To find the present developments in energy sector.

UNIT – I INTRODUCTION **6**

Units of energy, conversion factors, general classification of energy, world energy resources and energy consumption, Indian energy resources and energy consumption, energy crisis, energy alternatives, Renewable and non-renewable energy sources and their availability. Prospects of

Renewable energy sources

UNIT – II CONVENTIONAL ENERGY **9**

Conventional energy resources, Thermal, hydel and nuclear reactors, thermal, hydel and nuclear power plants, efficiency, merits and demerits of the above power plants, combustion processes, fluidized bed combustion.

UNIT – III SOLAR ENERGY **10**

Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooling, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar energy application in India, energy plantations.

UNIT – IV WIND ENERGY **10**

Wind energy, types of windmills, types of wind rotors, Darrieus rotor and Gravian rotor, wind electric power generation, wind power in India, economics of wind farm, ocean wave energy conversion, ocean thermal energy conversion, tidal energy conversion,
geothermal energy.

UNIT – V BIOMASS ENERGY **10**

Biomass energy resources, thermo-chemical and biochemical methods of biomass conversion, combustion, gasification, pyrolysis, Biomethanation Process - Economics of biogas plant with their environmental and social impacts - Bioconversion of substrates into alcohol - Methanol & ethanol Production.

Total: 45 periods

OUTCOMES: At the end of the course the students would be able to

1. Explain the fundamentals characteristics of renewable energy sources and their differences compared to fossil fuels.
2. Illustrate the conventional energy sources and its applications.
3. Classify different renewable energy technologies and choose the most appropriate based on local conditions.
4. Explain the technological basis for harnessing renewable biomass energy sources.
5. Understand the significance and procedure for energy conservation and audit.

Textbooks:

1. P.K. Nag, Power Plant Engineering, McGraw Hill Education, Fourth edition, 2012.
2. Rao, S. and Parulekar, B.B., Energy Technology, Khanna Publishers, 2007.

References:

1. El. Wakil, Power Plant Technology, Tata McGraw Hill, New York, 2012.
2. Fundamentals and Applications of Renewable Energy | Indian Edition, by Mehmet Kanoglu, Yunus A. Cengel, John M. Cimbala, cGraw Hill; 2020,
3. Rai.G.D., “Non-Conventional Energy Sources”, Khanna Publishers, New Delhi, 2014.
4. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University

Press, U.K., 2012.

5. Twidell, J.W. & Weir A., "Renewable Energy Resources", EFNSpon Ltd., UK, 2015.

COs	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	-	-	-	-	-	1	1	-	-			
CO2	3	3	1	-	-	-	-	-	1	1	-	-			
CO3	3	2	2	-	-	-	-	-	1	1	-	-			
CO4	3	2	1	-	-	-	-	-	1	-	-	-			
CO5	3	2	1	-	-	-	-	-	1	-	1	-			
CO	3	2	1	-	-	-	-	-	1	1	1	-			

Open Elective-II

ME22781	ADDITIVE MANUFACTURING	L	T	P	C
		3	0	0	3

Course Objectives: The main learning objective of this course is to prepare the students for:

1 To introduce the fundamentals of 3D printing and additive manufacturing technologies.

2 To understand the different types of 3D printing processes and their applications.

3 To explore the design considerations for 3D printing.

4 To analyze the materials used in 3D printing and their properties.

5 To understand the post-processing techniques and quality control methods in 3D printing.

UNIT – I INTRODUCTION TO ADDITIVE MANUFACTURING **9**

Overview of 3D Printing and Additive Manufacturing - History and Evolution of Additive Manufacturing. Basic Principles of 3D Printing: Layer-by-layer material deposition. Types of Additive Manufacturing Technologies.

UNIT – II 3D PRINTING PROCESSES **9**

Fused Deposition Modeling (FDM) -.Stereolithography (SLA) - Selective Laser Sintering (SLS) - Direct Metal Laser Sintering (DMLS) - Electron Beam Melting (EBM) - Binder Jetting and Material Jetting: Principles and Applications

UNIT – III 3D PRINTING DESIGN CONSIDERATIONS **9**

Design for Additive Manufacturing (DfAM): Principles and Guidelines - Geometric Constraints and Design Challenges: Overhangs, Warping, Supports - CAD Modeling for 3D Printing: Software Tools, File Formats (STL, AMF, OBJ), and Conversion Process - Topological Optimization: Designing Lightweight Structures - Customizing Products: Design for Personalized Products and Mass Customization

UNIT – IV MATERIALS FOR 3D PRINTING **9**

Polymers for 3D Printing: PLA, ABS, PETG, Nylon, Polycarbonate - Metals for 3D Printing: Titanium, Stainless Steel, Aluminum, Inconel - Bio-based Materials: Bioplastics, Bioprinting in Healthcare.
Materials Selection for 3D Printing: Factors to Consider - Strength, Durability, Thermal Resistance, and Cost.

UNIT – V POST-PROCESSING AND QUALITY CONTROL IN 3D PRINTING **9**

Post-Processing Techniques: Removal of Supports, Surface Finishing, Polishing, and Coating. - Heat Treatment and Sintering: Techniques for Improving Material Properties - Quality Control and Inspection: Dimensional Accuracy, Surface Finish, and Structural Integrity - Industry Standards for 3D Printing: ISO/ASTM Standards - . Introduction to Industry 4.0.

Total **45**

COURSE OUTCOMES: At the end of the course the students would be able to

CO1 Understand the basics of 3D printing technologies and their industrial applications.

CO2 Explain different 3D printing processes and their specific advantages and limitations.

CO3 Select design principles specific to additive manufacturing for product development.

CO4 Interpret the properties of materials used in 3D printing and select the appropriate material for different applications.

CO5 Implement post-processing techniques and quality control measures to improve the performance and finish of 3D printed parts.

TEXT BOOKS:

1 Ian Gibson, David W. Rosen, Brent Stucker, "Additive Manufacturing Technologies," Springer, 2019.

2 Mohamed Gadalla, "3D Printing: The Next Industrial Revolution," Springer, 2021.

REFERENCES:

1 David S. H. Rosenthal, "3D Printing: Applications in Manufacturing," CRC Press, 2017.

2 J. Paulo Davim, "3D Printing and Additive Manufacturing," Springer, 2020.

3 Richard Hague, "Introduction to Additive Manufacturing," Wiley, 2017.

4 R. S. Gohil, "3D Printing and Additive Manufacturing Technologies," Elsevier, 2018.

5 Ankit Kumar, "3D Printing and Additive Manufacturing of Polymer Nanocomposites," Elsevier, 2020.

Course outcomes	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	-	-	-	-	-	-	-	-	-	-			
CO2	3	2	-	-	-	-	-	-	-	-	-	-			
CO3	3	2	-	-	-	-	-	-	-	-	-	-			
CO4	3	2	1	-	-	-	-	-	-	-	-	-			
CO5	3	2	1	-	-	-	-	-	-	-	-	-			
CO	3	2	1	-	-	-	-	-	-	-	-	-			

ME22782 **ELEMENTS OF MARINE ENGINEERING**

L	T	P	C
3	0	0	3

Course Objectives

1 To provide fundamental knowledge of marine machinery systems onboard ships.

2 To understand the construction and operational aspects of propulsion machinery systems.

3 To explore the design and application of auxiliary machinery systems in marine operations.

4 To impart knowledge about marine boilers and their role in ship operations.

5 To understand the working principles of ship propellers and steering mechanisms.

UNIT – I ELEMENTARY KNOWLEDGE ON MARINE MACHINERY SYSTEMS **9**

Marine Engineering Terminologies, Parts of Ship, Introduction to Machinery systems on board ships – Propulsion Machinery system, Electricity Generator system, Steering gear system, Air

compressors & Air reservoirs, Fuel oil and Lubricating Oil Purifiers, Marine Boiler systems

UNIT – II MARINE PROPULSION MACHINERY SYSTEM **9**

Two stroke Large Marine slow speed Diesel Engine – General Construction, Basic knowledge of Air starting and reversing mechanism, Cylinder lubrication oil system, Main lubricating oil system and cooling water system.

UNIT – III MARINE AUXILIARY MACHINERY SYSTEM **9**

Four stroke medium speed Diesel engine – General Construction, Inline, V-type arrangement of engine, Difference between slow speed and medium speed engines – advantages, limitations and applications

UNIT – IV MARINE BOILER SYSTEM **9**

Types of Boilers – Difference between Water tube boiler and Fire tube boiler, Need for boiler on board ships, Uses of steam, Advantages of using steam as working medium, Boiler mountings and accessories – importance of mountings, need for accessories

UNIT – V SHIP PROPELLERS AND STEERING MECHANISM **9**

Importance of Propellor and Steering gear, Types of propellers - Fixed pitch propellers, Controllable pitch propellers, Water jet propellers.

Total 45

OUTCOMES: At the end of the course the students would be able to

CO1 Identify and explain basic marine engineering terminologies and elementary machinery systems onboard ships.

CO2 Understand the construction and functioning of marine propulsion machinery systems.

CO3 Explain the differences and applications of various auxiliary machinery systems.

CO4 Explain the principles and operational significance of marine boiler systems.

CO5 Demonstrate the functionality and importance of ship propellers and steering mechanisms.

Textbooks:

1. K.Ramaraj, “Text book on Marine Engineering”, Eswar Press, Chennai, 2018
2. Taylor, “Introduction to Marine engineering”, Revised Second Edition, Butterworth Heinemann, London, 2011.

References:

1. J.K.Dhar, “Basic Marine Engineering”, Tenth Edition, G-Maritime Publications, Mumbai, 2011
2. Alan L.Rowen, “Introduction to Practical Marine Engineering, Volume 1&2, The Institute of Marine Engineers (India), Mumbai, 2006.
3. A.S.Tambwekar, “Naval Architecture and Ship Construction”, The Institute of Marine Engineers (India), Mumbai, 2015.
4. E.A. Stokoe, “Reeds Naval architecture for the marine engineers”, Fourth Edition,2009

5. KJ Rawson and EC Tupper, “Basic Ship theory I” Vol. 1,5th Edition,2001.

COs	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	-	-	-	-	-	-	-	-	-	-	-			
CO2	3	-	-	-	-	-	-	-	-	-	-	-			
CO3	3	-	-	-	-	-	-	-	-	-	-	-			
CO4	3	2	-	-	-	-	-	-	-	-	-	-			
CO5	3	2	-	-	-	-	-	-	-	-	-	-			
CO	3	2	-	-	-	-	-	-	-	-	-	-			

Open Elective 3

ME22783	COMPOSITE MATERIALS	L	T	P	C
		3	0	0	3

Course Objectives

1. To introduce the fundamentals of composite materials, their types, and their advantages.
2. To understand the structure, properties, and behavior of composite materials.
3. To explore various manufacturing techniques for composite materials.
4. To analyze the mechanical properties and testing methods for composite materials.
5. To study the application of composite materials in various industries and their performance in real-world conditions.

UNIT – I INTRODUCTION **9**

Definition of Composite Materials - Historical Development and Evolution of Composites - Types of Composites: Fiber Reinforced Composites, Metal Matrix Composites, Ceramic Matrix Composites, Polymer Matrix Composites, Advantages and Disadvantages of Composite Materials Applications of Composite Materials in Aerospace, Automotive, Marine, Civil Engineering, and Sports

UNIT – II STRUCTURE AND PROPERTIES OF COMPOSITE MATERIALS **9**

Micromechanics of Composites: Fiber and Matrix, Interface and Interphase- Macromechanics of Composites: Stress-Strain Behavior, Isotropic and Anisotropic Behavior.
Mechanical Properties: Tensile, Shear, Flexural, and Compressive Strength - Thermal Properties: Thermal Conductivity, Expansion, and Thermal Stability - Fatigue, Creep, and Fracture Behavior.

UNIT – III MANUFACTURING OF COMPOSITE MATERIALS **9**

Hand lay up method, compression and transfer moulding, pressure and vacuum bag process, filament winding, protrusion, Injection moulding of thermosets, Advantages and disadvantages of each method.

UNIT – IV TESTING OF COMPOSITE MATERIALS **9**

Mechanical Testing: Tensile, Compression, Flexural, and Impact Tests - Non-Destructive Testing (NDT) Methods: Ultrasonic Testing, X-ray, Thermography, and Acoustic Emission - Fatigue Testing: Low-Cycle and High-Cycle Fatigue Behavior.

UNIT – V APPLICATION OF COMPOSITE MATERIALS **9**

Structural Applications: Aerospace Components, Automotive Structures, Wind Turbine Blades - Functional Applications: Sensors, Composites for Electrical and Magnetic Applications- Environmental Performance: Durability, Aging, and Corrosion Resistance - Future Trends in Composite Materials: Smart Composites, Nanocomposites, and Sustainable Materials.

Total 45

OUTCOMES: At the end of the course the students would be able to

1. Understand the basics of composite materials, their types, and applications.
2. Classify the mechanical and thermal properties of composite materials and their behavior under different loading conditions.

3. Explain various manufacturing techniques to produce composite materials effectively.

4. Apply mechanical and non-destructive tests on composite materials to evaluate their performance.

5. Explain the applications and advantages in the use of composite materials in real-world engineering scenarios.

Textbooks:

1. R. M. Jones, "Mechanics of Composite Materials," Taylor & Francis, 2017.
2. R. C. Crews, "Introduction to Composite Materials," CRC Press, 2016.

References:

1. S. T. Peters, "Handbook of Composite Materials," Wiley, 1998.
2. P. K. Mallick, "Fiber-Reinforced Composites: Materials, Manufacturing, and Design," CRC Press, 2017.
3. M. W. Hyer, "Stress Analysis of Fiber-Reinforced Composite Materials," McGraw-Hill, 2009.
4. J. D. Whitney, "Composite Materials: Design and Applications," Prentice Hall, 2014.
5. L. S. Darken, "Composite Materials: Science and Engineering," Prentice Hall, 2012.

COs	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	-	-	-	-	-	-	-	-	-	-			
CO2	3	2	-	-	-	-	-	-	-	-	-	-			
CO3	3	2	-	-	-	-	-	-	-	-	-	-			
CO4	3	2	-	-	-	-	-	-	-	-	-	-			
CO5	3	2	-	-	-	-	-	-	-	-	-	-			
CO	3	2	-	-	-	-	-	-	-	-	-	-			

ME22784 **PRODUCTION MANAGEMENT**

L	T	P	C
3	0	0	3

Course Objectives

1 To provide an understanding of the principles and concepts of production management.

2 To comprehend the process of planning, designing, and controlling production systems.

3 To explore various techniques for efficient resource management in production environments.

4	To understand the role of quality management in production processes.
5	To examine the application of modern trends in production such as automation, lean manufacturing, and sustainability.

UNIT – I INTRODUCTION TO PRODUCTION MANAGEMENT **9**

Definition, Scope, and Objectives of Production Management. Types of Production Systems: Job Shop- Batch- Mass Production- Continuous Production. Introduction to Manufacturing Systems: Make-to-Order and Make-to-Stock.

UNIT – II FACILITY PLANNING AND LAYOUT DESIGN **9**

Facility Location: Importance- Factors affecting location decisions. Plant Layout: Types of layout (Process, Product, Cellular, Fixed Position)
Factors Affecting Layout Design- Principles of Layout Planning. Material Handling Systems: Types and Selection Criteria- Modern Layout Design Techniques: Computer-Aided Design (CAD) in Layout Planning.

UNIT – III PRODUCTION PLANNING AND CONTROL (PPC) **9**

Definition and Importance of PPC- Capacity Planning: Methods and Techniques - Aggregate Planning: Strategies, Inputs, and Outputs- Master Production Scheduling (MPS) - Materials Requirement Planning (MRP) - Just-in-Time (JIT) Manufacturing - Inventory Control and Management: EOQ, ABC Analysis, Safety Stock, Reorder Point.

UNIT – IV QUALITY MANAGEMENT IN PRODUCTION **9**

Introduction to Quality Management Systems (QMS) - Quality Control: Methods, Tools, and Techniques (e.g., Six Sigma, Statistical Process Control, Pareto Analysis)- Six Sigma and Lean Manufacturing in Production - Quality Function Deployment (QFD) - Total Productive Maintenance (TPM).

UNIT – V MODERN TRENDS IN PRODUCTION MANAGEMENT **9**

Automation and Robotics in Production Systems - Lean Manufacturing: Principles, Tools, and Techniques - Sustainability in Production: Green Manufacturing, Eco-efficiency
Industry 4.0: Smart Manufacturing, IoT, and Cyber-Physical Systems - Agile Manufacturing and Flexible Production Systems.

Total 45

OUTCOMES: At the end of the course the students would be able to

CO1	Explain the principles, scope, and objectives of production management and its role in competitive manufacturing.
CO2	Explain the significance of facility planning and layout design in optimizing production processes.
CO3	Apply production planning and control techniques to manage resources effectively in a production environment.
CO4	Apply quality management tools and techniques to ensure high-quality standards in production.
CO5	Apply modern trends in production management such as automation, lean manufacturing, and sustainability.

Textbooks:

1. S. K. Sharma, "Production Management," Pearson, 2017.

2. R. P. Sahu, "Production and Operations Management," Himalaya Publishing House, 2015.

References:

1. P. A. V. P. S. Murthy, "Production Management," Tata McGraw Hill, 2014.
2. K. K. Ahuja, "Production Management: Text & Cases," Khanna Publishers, 2013.
3. M. Adithan & S. M. Deshmukh, "Production Management," New Age International, 2012.
4. M. L. Mahajan, "Industrial Engineering and Production Management," Dhanpat Rai & Sons, 2016.
5. P. Narayana, "Production and Operations Management," McGraw Hill, 2018.

COs	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3			-	-	-	3	-	-	-	-	-			
CO2	3	-	-	-	-	-	3	-	-	-	-	-			
CO3	3	3	2	-	-	-	2	-	-	-	-	-			
CO4	3	3	2	-	2	-	2	-	-	-	-	-			
CO5	3	3	-	-	-	-	2	-	-	-	2	-			
CO	3	3	2	-	2	-	2	-	-	-	2	-			