

3D PRINTING

Course Code: MEOE01

Prerequisite: Nil

Course Coordinator: Dr JAYA CHRISTIYAN K G

Course Credits: 3:0:0

Contact Hours: 42

Preamble

This course addresses additive manufacturing principles, variety and its concept, scope of additive manufacturing and areas of application. The current marketplace is undergoing an accelerated pace of change that challenges companies to innovate new techniques to rapidly respond to the ever changing global environment. A country's economy is highly dependent on the development of new products that are innovative with shorter development time. Organizations now fail or succeed based upon their ability to respond quickly to changing customer demands and to utilize new innovative technologies. In this environment, the advantage goes to the firm that can offer greater varieties of new products with higher performance and greater overall appeal.

At the center of this environment is a new generation of customers. These customers have forced organizations to look for new methods and techniques to improve their business processes and speed up the product development cycle. As the direct result of this, the industry is required to apply new engineering philosophy such as Rapid Response to Manufacturing (RRM). RRM concept uses the knowledge of previously designed products in support of developing new products.

Course Learning Objectives

1. The aim of the course is to provide the students, with an opportunity to conceive, design, and implement products quickly and effectively, using the latest Additive Manufacturing Techniques.
2. Technologies associated with material addition process are identified and its advantages are evaluated.
3. Students learn to differentiate various process parameters associated with Additive Manufacturing Technique & choose tooling techniques for a specific application.
4. Learn how relative improvements can be established by using computers and optimization techniques as compared to initial, manual solutions.

5. Students learn the Software associated with rapid prototyping techniques is explored.

UNIT I

Additive Manufacturing, The Generic AM Process, AM Information work flow, AM – An Integral part of Time compression Engineering, The Benefits of AM, Distinction Between AM and CNC Machining.

Reverse Engineering Technology: Introduction to reverse Engineering, Computer aided forward/Reverse Engineering, Reverse Engineering Hardware, Contact methods, Non contact Methods, Reverse Engineering Software.

UNIT II

Classification of AM Processes: Liquid Polymer Systems, Discrete Particle Systems, Molten Material Systems, Solid Sheet Systems, New AM Classification Schemes, Metal Systems, Hybrid Systems,

Design for AM: Part Orientation, Removal of Supports, Hollowing Out Parts, Reduction of Part Count in an Assembly.

UNIT III

Vat Photo polymerization Processes: Introduction, Vat Photo polymerization Materials, Photo polymerization Process,

Powder Bed Fusion Processes: Introduction, Materials, Powder Fusion Mechanisms, Process Parameters and Modeling, Polymer Laser Sintering

UNIT IV

Extrusion-Based Systems: Introduction, Basic Principles, Fused Deposition Modeling from Stratasys, Materials, Limitations of FDM, Bio extrusion,

Directed Energy Deposition Processes: Introduction, Material Delivery, Powder Feeding, Wire Feeding, Laser Based Metal Deposition Processes; Electron Beam Based Metal Deposition Processes

UNIT V

Direct Methods for Rapid Tool: RTV Tools, Paper Pulp Molding Tools

Indirect Methods for Rapid Tool Rapid Tooling: Silicone rubber tooling, Aluminum filled epoxy tooling, and Spray metal tooling.

Applications for Additive Manufacture: Medical, art models, Engineering analysis models, Functional models

TEXT BOOKS:

1. Additive Manufacturing Technologies, I. Gibson l D. W. Rosen l B. Stucker, Springer New York Heidelberg Dordrecht London, 2010.
2. Stereo lithography and other RP & M Technologies, Paul F.Jacobs: “SME, NY 1996.
3. Rapid manufacturing, FIham D.T &Dinjoy S.S verlog London 2001.

REFERENCE BOOKS:

1. Rapid prototyping, Terry Wohler’s Report 2000” association 2000.
2. Rapid prototyping materials by Gurumurthi. IISc Bangalore.
3. Rapid automated by lament wood. Indus press New York.

Course Outcomes (COs):

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

1. Describe the differences and of the application of a range of additive manufacturing processes[PO1,PO2,PO4,PO12,PSO1,PSO2]
2. Select and use correct CAD formats in the manufacture of a 3D printed part. [PO1,PO2,PO4,PO12,PSO1,PSO2]
3. Understand the operating principles, capabilities, and limitations of liquid and solid based additive manufacturing system, including fused deposition modeling and stereolithography. [PO1,PO2,PO3,PO4,PO5,PO12,PSO1,PSO2]
4. Appreciate the operating principles, capabilities and limitations of powder based additive manufacturing system, including 3D printing and laser sintering[PO1,PO2,PO3,PO4,PO5,PO12,PSO1,PSO2]
5. Describe the important process parameters of AM techniques[PO1,PO2,PO3,PO4,PO5,PO12,PSO1,PSO2]

FINITE ELEMENT METHOD

Sub Code: MEOE02

Credits: 3:0:0

Prerequisite: Nil

Preamble

Finite Element Method is proving to be a very powerful technique of solving and analyzing complex engineering problems. It is a numerical method which yields fairly accurate results for complex engineering problems and of late has emerged as a very rapidly growing area of research for applied mathematics. Its usefulness in various branches of engineering is due to the ease with which the method is made amenable to computer programming, leading to a process of iterative design. Its uniqueness lies in the fact that complex engineering problems having no analytical solutions can be solved with ease and iterative designs can be worked out. Of late, this technique has found a lot of applications in the area of manufacturing as newer and specialized techniques and materials are being used with changing technology. In this context it is desirable to introduce the subject of FEM in the curriculum of BE course as an open elective for other branches to train the students for developing skills for designing and analyzing the various manufacturing processes to arrive at an optimized process. The method can also be used in the development of machine tools, newer materials and failure analysis of processes.

Course Learning Objectives

1. To understand basics of engineering mechanics and finite element methods.
2. To understand finite element formulation for 1D and 2D problems.
3. To be able to solve bar, truss and beam problems using finite element method.
4. To understand linear and non linear principles in engineering mechanics.
5. To be able to understand the working principle of finite element analysis commercial package.

UNIT I

Introduction: Stress, strain, equilibrium equations and compatibility conditions, stress- strain relations, kinetic and potential energy associated with deforming bodies, Principle of minimum potential energy. Mathematical models and solutions of physical problems - Analytical and Numerical solutions, the overview of finite element method (FEM) - Basic steps of finite element methods.

UNIT II

Bar Element: Need and applications of bar element, coordinate system, Local coordinate system, natural coordinate system, Shape functions of linear simplex element, stiffness matrix by potential energy approach, Load vector, Problems on bar subjected to simple loading.

UNIT III

Truss Element: Need and applications of truss element, truss element, Elemental stiffness matrix, Element stress, Problems on trusses.

UNIT III

Beam element: Need and applications of beam element, Hermite shape function, Stiffness matrix, Load vector, Problems on beams.

UNIT IV

CST and Quad elements: Introduction, shape functions and strain - displacement matrix of CST and four node quadrilateral element, simple numerical

UNIT V

Introduction to higher order elements: three and four node 1D elements, six node triangular element, eight and nine node quadrilateral element.

FEA packages: Preprocessor, solver, post processor, latest FEA package available and their capabilities.

TEXT BOOKS

1. Finite Element IN Engineering, Chandrupatla T.R., 2nd Edition, PHI,2000
2. The Finite Element Method in Engineering, S.S.Rao, 4th Edition, Elsevier, 2006

REFERENCE BOOKS

1. Text book of Finite Element Analysis, P.Seshu, 2004
2. Finite Element Method, J.N.Reddy, McGraw- Hill International Edition.
3. Finite Element Analysis, C.S. Krishnamurthy,- Tata McGraw Hill Publishing co. Ltd, New Delhi , 1995

Course Outcomes

1. By the end of this course, the student will be able to recite and interpret the importance of FEM in engineering mechanics. (PO1,2,3,4,5,7,PSO1 &PSO2)
2. By the end of this course, the student will be able to derive shape functions, stiffness matrix, load vectors and mass matrix for a given 1D and 2D element. (PO1,2,3,4,5,7,PSO1 &PSO2)
3. By the end of this course, the student will be able to demonstrate the principle of FEM in solving bar, truss and beam problems. (PO1,2,3,4,5,7,PSO1 &PSO2)
4. By the end of this course, the student will be able to identify the application of higher order elements. (PO1,2,3,4,5,7,PSO1 &PSO2)
5. By the end of this course, the student will be able to understand the application of FEM software packages in solving the engineering mechanics problems. ((PO1,2,3,4,5,7,PSO1 &PSO2)

SUSTAINABLE WASTE MANAGEMENT TECHNIQUES

Course Code: MEOE03

Prerequisite: Nil

Course Coordinator: Dr JYOTHILAKSHMI R

Course Credits: 3:0:0

Contact Hours: 42

Course Learning Objectives:

- 1) Being a member of a planet, we have to understand how the ecosystem of the planet is deteriorated in the last two centuries. Sources of deterioration, types of waste generated, and the manners, in which wastes are managed, are to be studied.
- 2) Grasping the humongous problem and thinking about the methods to tackle it.
- 3) Minimizing waste generation will only postpone the debacle.
- 4) Designing new methods of not generating waste.
- 5) Understanding practical aspects of waste management and develop sustainable methods to manage the waste management systems.

UNIT I

Municipal solid waste management—Introduction, types of wastes, and sources, composition, generation rate, collection of waste, separation, transfer and transport, treatment and disposal options. Special emphasis on a) single-use plastics 2) e-waste 3) urban mining.

UNIT II

Sustainability-Introduction, 10 reasons for business to become sustainable. Waste defined, typical forms of waste. Biases towards waste. 4-steps to achieve sustainability as an objective. Stahel's ratio of manpower to energy use in production and closed-loop material recovery. Life extension -beginning with waste elimination. Managing the change. Saving waste. Micro- power generation. 10 ways to minimize product waste. Minimizing packages. Reuse, Repair, Remanufacture and Recycle.

UNIT III

Cradle to Cradle (C2C). Brief history of industrial revolutions. Cradle to Grave design. Strategy of tragedy or strategy of change. “ Less bad “ is no good .The four Rs. Ecoeffectiveness. Waste equals food To metabolism. Diversity. Natural energy flows. Diversity of “Isms”. An Industrial Revolution. 5 steps to ecoeffectiveness. 5 guiding principles. Cradle to Cradle design, guidelines.

UNIT IV

C2C certification process. New products developed in this field. Problems of incineration, land filling and composting. Ways to follow C2C. Water saving. Related concepts—Biomimicry, Blue economy, Industrial ecology, Resource recovery, System thinking and Biosphere Rules.

UNIT V:

Field Trips and Case Studies on Solid waste management sites, case studies, summary and report preparation. Preparation of detailed steps for implementation of waste management methods learnt.

Course Outcomes:

After going through this course the student will be able to:

1. Understand the concept of waste generation, types of wastes and characterization of waste[PO1-PO5]
2. Demonstrate ways of eliminating waste generation and methods of energy generation using waste along with the concepts of repair, Remanufacture and recycle[PO1-PO5]
3. Understand the concept of cradle to cradle design systems[PO1-PO5]
4. Understand C2C certification process and new product development[PO1-PO5]
5. Analyse practical aspects of Waste management and come out with sustainable solutions[PO1-PO5]

REFERENCE BOOKS:

- 1) Waste to wealth: The circular economy advantages by Peter Lacy and Jacob Rutqvist
- 2) The circular economy: A wealth flows-Ken Webster, Ellen MacArthur
- 3) Integrated Solid Waste Management George Tchobanoglous et al
- 4) Manual on Municipal Solid Waste Management
■ Govt of India, CPHEEO, Ministry of Urban Development, New Delhi, 2000
- 5) Upcycle ---William McDonough and Michael Brangart
- 6) The Sustainable Business---Jonathan T. Scott
- 7) Cradle to Cradle --William McDonough and Michael Brangart

TRADITIONAL INDIAN SCIENCE AND TECHNOLOGY

Course Code: MEOE04

Prerequisite: Nil

Course Coordinator: Dr. B P HARICHANDRA

Course Credits: 3:0:0

Contact Hours: 42

Preamble: Once referred to as vishwa guru, India is known for its science and technological heritage. While on one side several of India's technological marvels are unparalleled and unable to be duplicated even today, on the other side there are several unexplored literature not brought to light even today. This course serves as an overview and a motivation to the students to learn about the traditional sciences and technologies of India.

Course Learning Objectives:

To teach the students to:

- To have knowledge of areas where Indians had excelled in Traditional Indian Sciences and Technologies (TISTs)
- To understand some of the traditional technologies, which could have some modern applications
- To understand some of the traditional technologies, which are/were far more superior and challenging than the modern ones
- To understand the pioneering science and technologies of India
- To be able identify research potentials in TISTs

UNIT I

Introduction: Scope, authors of ancient Indian books/theories/formulae, vedic literature. Introduction to Indian medical sciences and Yoga, Typical nanomedicines in AYUSH systems. Research potentials. Introduction to state of Indian agriculture and agri-business.

UNIT II

Materials: Metallurgy: Brozes of South India, Iron and Steel, Zinc and its alloys, alloys and metallurgical technologies, Typical marvels of Indian Iron, Introduction to Rasaratnasamucchaya, , removal of impurity (shodhana), nanomaterials-their traditional methods. Research potentials.

UNIT III

Aeronautics: Rockets and Rocketry, Bharadwaja Vimanashastra. Research potentials.

UNIT IV

Astronomy: Time scale, measurement of time, astronomical instruments and observatories. Description of planets, grahas, earth, sun and moon.

UNIT 5

Vedic mathematics: Introduction to vedic mathematic sutras, Simple numerical-Multiplication, division, squares, square roots, cubes, simultaneous equations, Taylor series, Leibnitz power series, modified Leibnitz series, infinite GP. Geometrical studies, magic squares. Value of pi in Indian mathematics.

Course outcomes:

At the end of the course, the students:

- Will be able to identify areas where Indians had excelled in Traditional Indian Sciences and Technologies (TISTs)
- Would have understood some of the traditional technologies, which could have some modern applications
- Would have understood some of the traditional technologies, which are/were far more superior and challenging than the modern ones
- Would have understood typical pioneering science and technologies of India
- To be able identify research potentials in TISTs

TEXT BOOKS:

1. Indian Scientific Heritage – Dr. N Gopalakrishnan, Indian Institute of Scientific Heritage, Thiruvananthapuram, kerala
2. Yoga: Its basis and applications – Dr. H R Nagendra, Swami Vivekananda Yoga Prakashana, Bangalore, India
3. Vymaanikashaastra – Aeronautics by Maharshi Bharadwaaja, translated by G R Josyer, International academy of Sanskrit research.
4. Rasaratna Samuchaya – A D Satpute, Chowkamba Sanskrit Prathistan
5. Encyclopedia of Classical Indian Sciences – Dr. Roddam Narasimhan and Helaine Selin, Vijaykumar Govindram Hasanand Publications, University Press (India) Pvt. Ltd., Hyderabad
6. Faculty Notes

REFERENCE BOOKS:

1. Founders of sciences in Ancient India – Swamy Sathyaprakash Saraswathi
2. Indian Technological Heritage – Dr. N Gopalakrishnan, Indian Institute of Scientific Heritage, Thiruvananthapuram.

3. Science & Technology in 18th Century, Prof. Dharampal, Other India Press, Mapusa, Goa.
4. Vedic Mathematics – Bharathi Krishna Theertha Swamiji, MBLD Publications, New Delhi.