COURSE CONTENT

AEROSPACE MATERIALS AND MANUFACTURING PROCESS								
III Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
BAEE29	Elective	3	-	-	3	40	60	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		
Prerequisite: Aerodynamics								

I. COURSE OVERVIEW:

Aerospace materials are light-weight structural materials capable of withstanding severe environments and extreme stress levels. The course is intended to provide an overview of metallic, ceramic, polymeric and composite materials used for construction of spacecraft and their composition-structure-processing property correlation. This course focuses on the various processing techniques for metals, polymers and ceramics. The process parameters involved in the processing and their influence on the final shape of the product is discussed. Design of tools and other accessories for manufacturing a healthy product is also included.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The materials used and their property requirements for different parts of spacecraft
II. The composition- structure-processing-property correlation in aerospace materials to enable them to design new materials with improved property.
III. The manufacturing techniques of various materials

III. COURSE OUTCOMES:

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

CO 1 Discuss different types of materials, properties processes and types of heat treatment given for aerospace components.
CO 2 Evaluate the composition-structure-processing-property correlation of aerospace
CO 3 Analyze functional requirements of components and suggest suitable material and manufacturing process for the same.
CO 4 Compare and contrast various manufacturing techniques to obtain simple and complex shapes, and apply appropriate techniques to produce desired shapes.
CO 5 Analyze component failures and suggest remedies in terms of materials and processes.
CO 6 Use appropriate database tools to select suitable combination of materials and manufacturing process for a specified application.

IV. COURSE CONTENT:

MODULE-I: CARBON BASED AND CERAMIC MATERIALS (09)

Carbon based materials: Carbon fiber- precursors and production, properties; carbon-carbon composites production, properties and applications; Carbon aero-gels; Carbon foams;

Ceramic materials: Polymer derived ceramics- synthesis, processing of pre-ceramic polymers, ceramic fibers, Ceramic matrix composites, Thermal barrier coatings, Ablative materials, Silica tiles, Ceramic aerogels, Porous ceramics and ceramic foams, Ultrahigh temperature ceramics- TiB2, ZrB2, HfB2 and their composites, Materials with zero thermal expansion-glass ceramics-preparation and application

MODULE-II: METALLIC MATERIALS AND MATERIALS FOR AEROSPACE APPLICATIONS (09)

Metallic materials: Certification and testing of Aerospace materials. Metallic materials: Aluminum alloys, Super alloys, - microstructure, properties and applications High temperature polymers: Aromatic liquid crystalline polyesters, Phenolics, Polyimide, Poly ether ether ketones- synthesis, processing and applications

Materials for cryogenic applications: Metals for low temperature applications, Austenitic stainless steel, Nitrogen containing steel, Aluminium, Aluminium-lithium alloys, Titanium alloys, Cryo insulation materials, Polymers and adhesive for cryo temperature applications

Materials for space environment: Radiation shielding materials, Atomic oxygen resistant materials, Space suit materials and materials for life support systems, Evaluation of materials for space environment and space worthiness

MODULE-III: CORROSION, COATING AND FAILURE ANALYSIS (09)

(Corrosion, Coatings and Failure Analysis): Corrosion observed in aerospace components and its prevention; Coating: Significance of coating for aerospace components, Thermal Barrier Coatings (TBCs), Stealth technology, Coating techniques like thermal deposition, laser, PVD, CVD etc. Non Destructive Testing (NDT) techniques and Failure analysis: Different types of NDT techniques and their application for aircraft applications, case studies on failure analysis of components/systems

MODULE-IV: METALLIC PROCESSING (09)

Metallic processing: Casting process- major casting techniques, Solidification and volume shrinkage, Casting design and defects, Fundamentals of deformation processing, Deformation work, Hot and cold working, Few forming processes and defects; Metal joining process- Weldability, Concepts of Fusion and solid state welding processes.

Processing of traditional ceramics- spray granulation, Pressing, CIP, HIP, Slurry processing, Slip casting, Pressure casting, Tape casting, Gel casting, Injection molding, Extrusion; Rapid prototyping through Additive manufacturing, Electrophoretic deposition, Production of ceramic fibres, Electro-spinning; Drying, Binder burnout, Green machining, Sintering; Sol-gel processing, Thermal and plasma spraying, Thick and thin film coatings- PVD and CVD techniques; Vapor infiltration techniques

MODULE-V: DESIGN ASPECTS (09)

Design aspects: General principles of materials selection and design based on requirements of function, Property, Processability and cost; Quantitative methods of materials selection, Materials performance index; Design of engineering structures from the atomic- and nano-scales to macroscopic levels; Case studies- modern metallic, ceramic, polymeric and biomaterials devices and components.

V. TEXT BOOKS:

1. M. Scheffler, P. Colombo, Cellular Ceramics, Structure, Manufacturing, properties and Applications, 1st edition., Wiley-VCH, 2006.
2. W.D. Kingery, H.K. Bowen, D.R. Uhlmann, Introduction to Ceramics, 2nd edition, Wiley-Interscience, 1976.

3. P. Boch, J-C. Nièpce, Ceramic Materials: Processes, Properties, and Applications, Wiley-ISTE, 2007.
4. Z. Tadmor, C.G. Gogos, Principles of Polymer Processing, 2nd ed., Wiley International, 2006

VI. REFERENCE BOOKS:

1. H.M. Flower, High Performance Materials in Aerospace, 1st ed., Chapman & Hall, 1995.
2. E. Degarmo, J.T. Black and R.A. Kohser, Materials and Processes in Manufacturing, 9th ed., Wiley, 2002.

S. Kalpakjian, S.R. Schmid, Manufacturing Engineering and Technology, 6th ed., Pearson, 2009.

VII. ELECTRONICS RESOURCES:

1. http://www.sandia.gov/~ktcarlb/opt_class/OPT_Lecture1.pdf
2. http://www.ifp.illinois.edu/~angelia/optimization_one.pdf
3. http://www3.imperial.ac.uk/pls/portallive/docs/1/7288263.PDF

VIII. MATERIALS ONLINE

1. Course template.
2. Assignments.
3. Tutorial question bank.
4. Model question paper – I.
5. Model question paper – II.
6. Lecture notes.
7. Power point presentations.