VEL TECH
Dr.RR & Dr.SR
TECHNICAL UNIVERSITY
VEL TECH RANGARAJAN Dr.SAGUNTHALA
R&D INSTITUTE OF SCIENCE AND TECHNOLOGY
University u/s 3 of UGC Act, 1956
#42, Avadi-Vel Tech Road, Avadi, Chennai - 600 062, Tamil Nadu, INDIA.

ARAI
Progress through Research

M.Tech Programme in

AUTOMOTIVE MATERIALS AND MANUFACTURING

SYLLABUS

ACADEMIC YEAR 2011 – 2013

In Association with

The Automotive Research Association of India, Kothrud, Pune

ARAI-Forging Industry Division, Chakan, Pune

SYNOPSIS

VelTech Dr. RR and SR Technical university, Chennai and Automotive Research Association of India (ARAI) signed MoU to commence Post Graduate M. Tech. programs in Automotive Engineering. One of them is "**Automotive Materials and Manufacturing"**. The proposed program is of 2 years duration and will be arranged at Vel Tech Dr RR and Dr SR Technical University, Chennai, ARAI Forging Industry Division, Chakan and ARAI, Pune. The program module will be –

- One year at Vel Tech Dr RR and Dr SR Technical University consisting of Semester I & II to cover up lectures, tutorials, Industrial visits and practicals.
- One year at ARAI Forging Industry Division, Chakan and ARAI, Pune consisting of six months lectures and practicals, industry visit in Semester III and six months of Semester IV for the project / thesis activity.

Objective

To impart knowledge on automobile engineering focusing more on various metals & alloys, polymers & composites, advanced materials that are used for components, their manufacturing, performance requirements, heat treatment, designing, testing & characterization and selection processes.

Benchmarking Universities

Most of universities elsewhere in India and abroad offer PG courses on Automobile Engineering, Automotive Materials, Manufacturing Methods, Advanced Materials, etc either as electives or independent one. An exclusive M. Tech. program is nowhere taught to call as a benchmark. Hence referring the part of the following Universities and their PG specific programs, the M. Tech curriculum is worked out as unique in nature.

- Waterloo Center for Automotive Materials and Manufacturing (WatCAMM), University of Waterloo
- Center for Light weighing Automotive Materials and Processing (CLAMP), University of Michigan, Dearborn.
- University of Nottingham, UK
- University of Windsor
- College of Engineering Pune (COEP)
- NIT Rourekela
- R V College of Engineering, Bangalore
- Anna University, Chennai, Trichy and Coimbatore

Intended Learning Outcomes

- **Knowledge and Understanding**
  - By the end of course student should know automobile engineering, components and materials that go in automotive manufacturing, effects of heat treatment processes to use and share it in the daily life, understand the Material selection processes, Value engineering and localization of automotive components.
- **Intellectual skills**
  - Design of components and manufacturing in alternate lightweight materials
  - Visionary knowledge on emerging Smart materials.
- **Professional and Practical skills**
  - Metal forging simulation using advanced CAE packages
  - Effects of heat treating processes on design and failures in practical life
  - Quality control skills through testing & characterization of materials, Quality systems, legislatives on recyclability, restrictions on use of hazardous materials, ELV, green house effects
- **General and transferrable skills**
  - Know-hows on selection of materials, Reasons that lead to failure to suggest remedial solutions
  - Project management and Soft skills essential in engineering industry

Faculty of Mechanical Engineering
M.TechAutomotive Materials and Manufacturing- ARAI

I SEMESTER at Vel Tech University

SL.NO	SUB. CODE	SUBJECT	L	T	P	C
1	P1MAIB08	Mathematical & Statistical Methods in Engineering	3	1	0	4
2	P1AMIB01	Automobile Engineering	3	0	2	4
3	P1AMIB02	Ferrous Materials and Manufacturing Processes	3	0	2	4
4	P1AMIB03	Non-ferrous Materials and Manufacturing Processes	3	0	2	4
5	P1AMIB04	Automotive Elastomers & Plastics	3	0	2	4
Practicals						
6	P1AMIB05	Industrial Training - I			6	3
Total Credits			**15**	**1**	**14**	**23**

II SEMESTER at Vel Tech University

SL.NO	SUB. CODE	SUBJECT	L	T	P	C
1	P2AMIB06	Composite Materials	3	1	0	4
2	P2AMIB07	Advances in Manufacturing Processes	3	0	2	4
3	P2AMIB08	Heat Treatment of Metals	3	0	0	3
4	P2AMIB09	Selection of Materials	3	1	0	4
5	******	Elective – I	4	0	0	4
Practical						
6	P2AMIB10	Industrial Training - II	0	0	6	3
Total Credits			**16**	**2**	**8**	**22**

L – Lectures/Week, T – Tutorials/Week, P – Practicals/Week; C – Credit

III SEMESTER at ARAI-FID, Chakan & ARAI, Pune

SL.NO	SUB. CODE	SUBJECT	L	T	P	C
1	P3AMIB11	Metallurgical Failure Analysis	3	1	0	4
2	P3AMIB12	Automotive Material Testing & Characterization	3	1	0	4
3	P3AMIB13	Advances in Automotive Materials and Processes	3	1	0	4
4	P3AMIB14	Soft Skills	2	0	2	3
5	P3AMIB15	Project Management	2	1	0	3
Practical						
6	P3AMIB16	Metal Forming Simulation Lab	2	0	2	3
7	P3AMIB17	Automotive Materials & Chemical Lab	0	0	6	3
Total Credits			**15**	**4**	**10**	**24**

IV SEMESTER at ARAI-FID, Chakan & ARAI, Pune

SL.NO	SUB. CODE	SUBJECT	L	T	P	C
1	P4AMIB18	Project Work	0	0	32	16
Total Credits			**0**	**0**	**32**	**16**

Over all Total Credits = 85

LIST OF ELECTIVES

SL.NO	SUB. CODE	SUBJECT	L	T	P	C
1	PEAMIB19	Design of Experiments & Optimization Techniques	3	1	0	4
2	PEAMIB20	Applied Tribology	3	1	0	4
3	PEAMIB21	Measurements and Instrumentation Systems	3	1	0	4
4	PEAMIB22	Engineering Reliability of Materials	4	0	0	4
5	PEAMIB23	Quality & Environmental Management System	4	0	0	4
6	PEAMIB24	Lean Manufacturing and Frugal Engineering	3	1	0	4

L – Lectures/Week, T – Tutorials/Week, P – Practicals/Week; C – Credit

P1MAIB08 MATHEMATICAL AND STATISTICAL METHODS IN ENGINEERING L T P C
3 1 0 4

OBJECTIVES

The course is designed to meet the mathematical and statistical requirements of engineering students of Automotive Materials and Manufacturing. It specifically aims are given below:

- To understand reliability in manufacturing processes;
- To understand shock phenomena in manufacturing processes;
- To develop knowledge of latest tools and techniques for manufacturing process and quality control;
- To develop knowledge of capability analysis and control techniques;
- To develop knowledge of experimental designs and improvement with designed Experiments;
- To develop methods for process optimization.

UNIT I PROBABILITY & RANDOM VARIABLES 12

Conditional probability; Baye's theorem; random variables; expectation; conditional expectation; moment generating function of special distributions (Geometric, Bernoulli, Binomial, Negative binomial, Poisson, exponential, gamma, Uniform, Weibull and normal); sequence of random variables; central limit theorem.

UNIT II STOCHASTIC PROCESSES & SIMULATION 12

Discrete-time Markov chains; Continuous-time Markov chains; Birth and Death processes; Renewal processes; Poisson process; compound Poisson process; Brownian motion; Simulation; Generation of Pseudo Random Numbers; Using Random Numbers to Generate Discrete Random Variables; Generating Continuous Random Variables.

UNIT III RELIABILITY AND SHOCK MODELS 12

Reliability concepts and measures; components and systems, coherent systems; Life distributions; reliability function, hazard rate, common life distributions; exponential, Weibull, gamma and beta distributions; Univariate shock models and the distributions arising out of them; bivariate shock models, common bivariate exponential distributions and their properties.

UNIT IV STATISTICAL METHODS 12

Statistical quality control – Control Charts for Variables and Attributes Process -- Measurement System Capability Analysis -- Multivariate Process Monitoring and Control Engineering Process Control -- SPC

UNIT V ANALYSIS OF VARIENCE AND DESIGN OF EXPERIMENTS 12

Analysis of Varience – one way and two way classifications, Design of experiments, basic principles – Randomization, Replication & local control – CRD, RBD & LSD. 2^2 & 2^3 factorial experiments, without confounding fractional experiments. Process Optimization

TOTAL: 45+15 (Tutorial) = 60 periods

REFERENCE BOOKS

1. Advances in Mathematical Modeling and Experimental Methods for Materials and Structures edited by Rivka Gilat, Laslie Banks-Sills,; The Jacob Aboudi Volume; Springer 2010
2. Sheldon Ross, Introduction to Probability Models, 8th edition, Academic Press, 2002.
3. Sheldon Ross, Stochastic Processes, 2nd edition, John Wiley & Sons, 1996.
4. Sheldon Ross, Simulation, Fourth edition, Academic Press, 2006.
5. Barlow R.E. and Proschan, F. Statistical Theory of Reliability and Life Testing, Holt Rinehart and Winston, New York, 1985
6. Montgomery, D. C., Statistical quality Control: A Modern Introduction, 6th edition, Wiley, 2010.
7. J. S. Oakland, Statistical Process Control, Butterworth-Heinemann, 2007.

P1AMIB01 AUTOMOBILE ENGINEERING L T P C
3 0 2 4

(Common with M. Tech. - Automotive Electronics & Embedded System)

OBJECTIVES

To understand the various automobile engines parts and fuel systems.
To impart knowledge to students in various systems of automobile engineering and to have the practice for assembling and dismantling of engine parts.

UNIT I VEHICLE STRUCTURE AND ENGINES 12

Types of automobiles Vehicle construction Chassis Frame and Body aerodynamics. Components of engine –Their forms Introduction to Electronics in Automobiles- to cover all sub systems in automobile technology- role of electronics and fundamentals of microcontrollers.

UNIT II EMISSION AND ALTERNATIVE FUELS 12

Functions and Materials Review of cooling and lubrication systems in engine Turbo Chargers Engine Emission control by 3 –way Catalytic controller Electronic engine management systems. Use of Natural Gas- LPG- Biodiesel- Gasohol and Hydrogen in Automobiles Electric and Hybrid Vehicles- Fuel Cells.- stoichio metric ratio- Fundamentals of Gasoline and Diesel Engines

UNIT III ENGINE AUXILIARY SYSTEMS 12

Carburetor – working principle, Electronic fuel injection system, Mono point and Multipoint Injection systems, Construction, Operation and maintenance of Lead acid Battery Electrical systems; Battery, generator, Starting Motor and drives –Lighting and Ignition (Battery- Magneto Coil and Electronic Type) Regulators –cut outs Starter alternator- Body Control module- Multiplexed wiring.
Various Electronic Control Units (ECU) used in automotive for various applications, their functions & Construction, Heat Sink for ECUs, Switches, Sensors, etc.

UNIT IV TRANSMISSION SYSTEMS 12

Clutch Types and Construction Gear Boxes- Manual and Automatic Transmission Simple Floor Mounted Shift Mechanism –Over Drives Transfer Box Fluid flywheel Torque converters Propeller shaft –slip joint Universal joints Differential and Rear axle Hotchkiss Drive and Torque tube drive- TCU

UNIT V STEERING- BRAKES AND SUSPENSION 12

Wheels and Types –Wheel alignment parameters Steering Geometry and Types of Steering gear box Power steering –Types of Front Axle –Suspension systems Braking systems –Types and construction – Diagonal Braking systems Antilock Braking systems. EPS roll over control integrated safety.

TOTAL: 60 periods

TEXT BOOKS

- Handbook of Automotive Engineering by Ulrich W. Seiffert, Hans Hermann Braess
- Automotive Engineering Fundamentals by Richard Stone and Jeffery K/Ball
- Sethi H.M-" Automobile Technology"- Tata McGraw Hill, 2003.
- Kirpal Singh-" Automobile Engineering Vol. 1 & 2 -"Standards Publishers - New Delhi.
- Newton Steads & Garret "Motor vehicles".
- W.H.Grouse "Automobile Engines"

P1AMIB02 FERROUS MATERIALS & MANUFACTURING PROCESSES L T P C

3 0 2 4

OBJECTIVE

The objective of the course is to train the students at an advanced level in the field of ferrous materials and their properties, selection criteria and applications for the automotive components.

UNIT I ENGINEERING MATERIALS 12

History metallurgy; Classification of engineering materials; mechanical, physical and thermal properties of engineering materials; Ashby Charts and selection of materials for wide applications; Introduction to manufacturing processes; Technical and economic considerations; Significance of material properties with respect to selection of manufacturing process

UNIT II FERROUS METALS 12

Iron-Carbon equilibrium diagram; Effects of alloy additions; Types of steel – plain carbon steels, low alloy steels, heat treatable steels, tool steels, die steels, stainless steels, special steels; International systems to classify steel grades – AISI/SAE, DIN, EN series/BS, BIS; Automotive grades and compositions; Mechanical, thermal, electrical and physical properties of steels, Automotive applications

UNIT III STEEL MAKING 12

Principles of steel making, melting practices – Development of steel making processes, physio - chemical principles and kinetic aspects of steel making, carbon boil, oxygen transport mechanism, desulphurization, dephosphorization, slag-functions, composition control, properties and theories, raw materials for steel making and plant layout, Effects of melting practices on end product.

UNIT IV STEEL METAL FORMING PROCESSES 12

Classification of conventional forming processes. Principle equipment used and applications of – Forging, Rolling: Cold & hot rolled, deep drawing quality, Extrusion: extruded tubes & products, Wire drawing, and Spinning techniques; Applications, Energy saving devices, safety systems and environment issues, carbon credits. Significances of Manufacturing Processes - Effects of manufacturing processes & heat treatments on end products, possible defects due to manufacturing methods & remedies; Cast Vs Rolled Vs Forged products; Selection of processes for auto applications

UNIT V CAST IRON 12

Types of Cast irons – grey cast irons, alloy CI, Spheroidal cast irons, white iron, malleable iron, vermicular cast irons; Chemical compositions and properties.

Various casting processes – Sand casting: Types, Procedure to make sand molds, selection and quality of sands, Core molding tools, Pouring of metals, Principles of – Die castings, Centrifugal castings, Investment casting, Shell molding, CO_2 process. Casting defects and their effects on products, International classification of grades, Applications of casting processes and cast iron grades for the auto components.

Total = 60 periods

TEXT BOOK

1. William D. Callister, Jr., "*Materials Science and Engineering an Introduction*", John Wiley & Sons, 6th Edition, , Inc., 2004.
2. V.Raghavan, "*Materials Science and Engineering*", Prentice Hall of India Pvt. Ltd.,5th Edition, 2007
3. Hajra Choudhary, "*Elements of Workshop Technology*", Asia Publishing House, Vol. I & II; 1996
4. R.K. Jain and S.C. Gupta, "*Production Technology*", Hanna Publishers, 1997
5. H.M.T. "Production Technology", Tata McGraw Hill, 1990

REFERENCE BOOK

1. Flinn, R.A., and Trojan, P.K., "*Engineering Materials and their Applications*", Jaico , 4th Edition, 1999.
2. ASM Metals Hand book, "*Failure Analysis and Prevention*", 10th Edition, Vol.11, ASM 2002.
3. Ashby M.F., "*Material Selection in Mechanical Design*", Butter Worth 3rd Edition, 2005.
4. Smithells Metals Reference Book, Eighth Edition
5. ASM Metals Hand Book, Vol.15, "Casting", ASM International, 10th Edition, 1991

P1AMIB03 NON–FERROUS MATERIALS & MANUFACTURING PROCESSES L T P C
3 0 2 4

OBJECTIVE

The objective of the course is to train the students at an advanced level in the field of non – ferrous materials and their properties, selection criteria and applications for the automotive components.

UNIT I DRIVING FORCES FOR LIGHTWEIGHT MATERIALS 12

Concept of end-of-life-of-vehicles (ELV) and directives, recyclability of materials, life cycle analysis (LCA), green-house effects, restrictions on use of hazardous materials, bio-degradability, eco-friendly nature; Fuel economy standards, emission norms, vehicle performance and safety regulations, NVH aspects, styling, special effects & consolidation of product assembly, etc.

UNIT II ALUMINIUM AND ALUMINIUM BASE ALLOYS 12

Enhancing properties of aluminium for auto applications; Cast and wrought forms; Classification system and grades of alloys; Roles of alloy additions on properties; Significance of various equilibrium diagrams in designing alloys; Solution treatment (age hardening) and microstructural changes; Chemical compositions & properties of aluminium alloys; Environmental benefits of recycling.
Aluminium alloy melting practices; Component forming processes – castings, extrusions, sheet forming and forgings, material defects and their significances on properties and performances on end product; Automotive applications of aluminium alloys and manufacturing processes for body to Powertrain components

UNIT III MAGNESIUM AND TITANIUM BASE ALLOYS 12

Properties and benefits over other traditional metals; Classifications of alloys; Melting practices; Manufacturing processes – Casting, extrusion and forging processes; Solution treatment and microstructures; Alloy compositions and properties; Surface coatings; Auto applications and limitations.

UNIT IV COPPER AND LEAD BASE ALLOYS 12

Alloy grades and properties; Grades of pure copper, Classification systems, Manufacturing processes; Microstructures and defect analysis, Auto applications

UNIT V OTHER METALLIC MATERIALS 12

Nickel base alloys; Be-Cd alloys; Zinc base alloys and grades, Tin & Antimony base alloys for bearings, Noble (Precision) metals and intermetallics for catalytic converters, Refractory metals and alloys for high temperature applications, grades, compositions, properties & applications, manufacturing processes.
Manufacturing processes for the Automotive Electronics Systems & Components like ECU, Switches, Sensors, etc.

TOTAL: 60 periods

TEXT BOOKS

1. Avner, S. H., "*Introduction to Physical Metallurgy*", second edition, McGraw Hill, 1985.
2. Henkel & Pense "*Structure and Properties of Engineering materials*", 2001
3. ASM Handbook, Vol. 2, "*Properties and Selection - Nonferrous Alloys and Special-Purpose Materials*"
4. ASM Handbook, Vol.3, "*Alloy Phase Diagrams*"

REFERENCES

1. Automotive Materials Recycle Bibliography; Argonne National Laboratory
2. "American National Standard Alloy and Temper Designation Systems for Aluminum," PP/2650/988/11, Aluminum Association, July 1988
3. "Registration Record of International Alloy Designations and Chemical Composition Limits for Wrought Aluminum and Wrought Aluminum Alloys," PP/2M/289/A1, Aluminum Association, Feb 1989
4. *Metals & Alloys in the Unified Numbering System,* 4th ed., Society of Automotive Engineers, 1986
5. J.G. Gensure and D. L. Potts, Ed., *International Metallic Materials Cross-Reference,* 3rd ed., Genium Publishing, 1983
6. "Registration Record of Aluminum Association Alloy Designations and Chemical Composition Limits for Aluminum Alloys in the Form of Casting and Ingot," Aluminum Association, Jan 1989
7. I.J. Polmear and M.J. Couper, "Design and Development of an Experimental Wrought Aluminum Alloy for Use at Elevated Temperatures," *Metall. Trans. A,* Vol 19A, p 1027-1035
8. R.S. Busk, *Magnesium Products Design,* Vol 1, Marcel Dekker, 1987, p 180
9. 1. R.J. Klein Wassink, *Soldering in Electronics,* 2nd ed., Electrochemical Publications, 1989
10. W.J. Kroll, How Commercial Titanium and Zirconium Were Born, *J. Franklin Inst.,* Vol 260, Sept 1955, p 169-192
11. *Titanium: The Industry, Its Future, Its Equities,* F.S. Smithers and Company, 1957, p 7, 33-67
12. H.B. Bomberger, F.H. Froes, and P.H. Morton, Titanium--A Historical Perspective, in *Titanium Technology: PresentS tatus and Future Trends,* F.H. Froes, D. Eylon, and H.B. Bomberger, Ed., Titanium Development Association, 1985,p 3-17.
13. V.T. Morgan, Porous Metal Bearings, in *Perspectives in Powder Metallurgy,* Vol 4, *Friction and Antifriction Materials,* Plenum Press, 1970, p 187-210
14. V.T. Morgan, Copper Powder Metallurgy for Bearings, in *New Perspectives in P/M,* Vol 7, *Copper Base Powder Metallurgy,* Metal Powder Industries Federation, 1980, p 39-63

P1AMIB04 AUTOMOTIVE ELASTOMERS AND PLASTICS **L T P C**
3 0 2 4

OBJECTIVE

The objective of the course is to train the students at an advanced level in the field of polymers; fiber reinforced plastics (FRP), engineering ceramics, metal matrix composites (MMCs) and its manufacturing methods, properties and applications for the automotive components.

UNIT I POLYMERIC MATERIALS **12**

Polymerization – Thermosets Vs Thermoplastics – Classes and types of polymers; Properties and limitations of plastic material species; Additives; Auto applications – exterior, interior, engine and fuel line, transmission systems, electrical and electronic components.

UNIT II MANUFACTURING PROCESSES **12**

Injection molding, Reaction injection molding (RIM), Transfer molding, Extrusion, compression molding, blow molding, scopes and limitations of various manufacturing processes, mold making, safety in handling of materials, hands on training on processes, selection criteria for auto applications, economics

UNIT III ELASTOMERS **12**

Physics of raw and vulcanized rubbers; Kinetic and thermodynamics theory of rubber elasticity; Stress-strain relationships for the vulcanized rubbers; Molecular basis for the material to act as rubber; Study of various additives like peptizers, antioxidants, accelerators, activators, fillers, carbon black, chords and fabrics, blowing agents, colorants, processing aids like – tackifiers, plasticizers, extender oils etc.

Characterization of compounds, rheological behaviors, properties influenced by compounding ingredients. Processing of rubbers by - extrusion, calendaring and injection molding. Manufacturing techniques of auto components – tires, belts, hoses, mounts wiper blades, seals, O rings, etc. Study of major synthetic auto rubbers like – NR, SBR, BR, IIR, NBR, SBR, fluorocarbons, silicone, etc – their functional properties and needs of auto industries; uses in fuel systems, chassis and body components, NVH applications.

UNIT IV DESIGN IN PLASTICS AND ELASTOMERS **12**

Selection of polymers, additives and process; Effects of mechanical, thermal, electrical properties, importance of environmental factors, structural analysis; Mold design; Part geometry; Gating, cooling, ejection, joining and assembling; Geometric tolerances; Safety factor & failure criteria; Machining, finishing and decorating, etc.

Designing in rubbers, effects of material, process and environment parameters, life cycle analysis, design software packages, failure mechanics. Case studies

UNIT V FOAMS, ADHESIVES, COATINGS AND PAINTS 12

PU & Latex foams - Formulations and manufacturing Control of various foam properties – density, modulus of elasticity, compression set, dynamic properties, etc.

Adhesives - Condensation polymerization of products like – phenol formaldehyde (Phenolic resins), Amino resins, Polyester resins, Alkyl resins, Epoxy resins, Polyurethane resins, Polyamide resins; Additional polymerization products like – Vinyl resins, Vinyl alcohol resins, vinylidine resins, Styrene resins and Acrylic resins.

Protective coatings and Paints - Organic paints and coatings, metal coatings, ceramic coatings, Linings, primers, varnishes, enamels, galvanizing, anodizing, blackodizing, electro plating, CVD & PVD surface coatings

Other Materials - Seals and Gaskets, Automotive glasses, Refractory materials

TOTAL: 60 periods

REFERENCE BOOKS

1. Kalyan Sehanobish, "*Engineering Plastics and Plastic Composites in Automotive Applications*", SAE International, April 2009

2. Francis Gardiner and Eleanor Garmson "*Plastics and the Environment*" Smithers Rapra, 2010

3. Mahendra D Baijal "*Plastic Polymer Science and Technology"*, John Wiley&Sons,1982

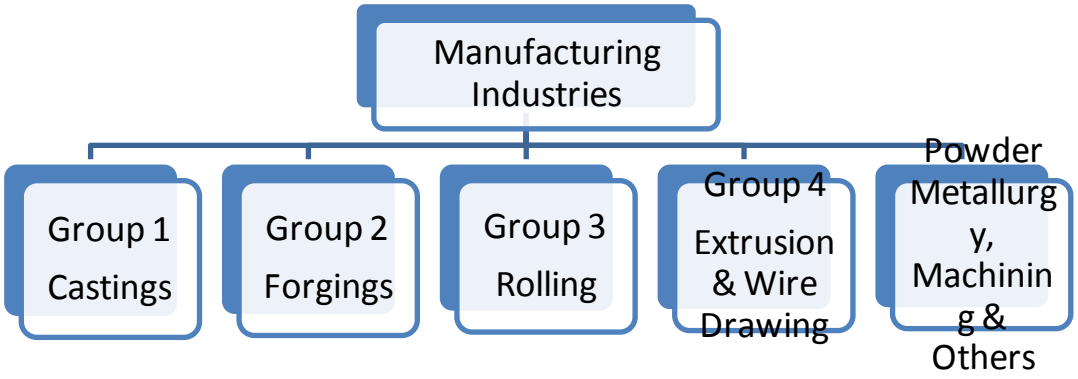
4. Natti S. Rao, Gunter "*Design Formulas for Plastic Engineers*"Hanser Publishers , 2nd Edition,2004

5. John Moalli "Plastics Failures", Plastics Design Library, William Andrew Inc, 2001

P1AMIB05 **INDUSTRIAL TRAINING - I** **L T P C**
0 0 6 3

(MANUFACTURING PROCESS INDUSTRY)

Students has just joined to the post-graduate course with the background of Bachelor degree in Engineering in varied streams i.e. Mechanical, Automobile, Aeronautical, Production, Manufacturing, Materials and Metallurgy or equivalent. Students have understood the fundamentals of core manufacturing processes and materials. Now with this background and continued specialized learning in the area of Automotive Materials & Manufacturing; the Industrial visit to the following Industries is arranged with the focus of Industry Problem Solving.



Students are encouraged to learn more about probable Industry problem during their visit; which they will continue in next semester under the course work of Industry Problem Solving – II. The understanding of manufacturing process should as under following three broad guidelines:

1. Value chain in a Manufacturing Industry.
2. Core manufacturing process of the Industry.
3. Problem solving techniques deployed in an Industry.

The above learning will be from the perspective of Materials and Metallurgy.

Vel Tech to tie-up with AIEMA, Ambattur to pre identify Problems or Tasks to be undertaken with the above stated types of process industries.

Prerequisite: A homework study on the relevant manufacturing process that is followed in the Industry to be visited is essential to identify probable problem in manufacturing in the initial combined class visit. This initial visit will then followed by a visit with probable problem definition. Student has to prepare a report and will do the presentation, followed by a question and answers. At the end of the semester, all the reports may be compiled in the form of a record. The visit coordinator shall award internal marks, based on the report submitted & presentation for a maximum of 50 marks. A viva-voce examination shall be organized for a maximum of 50 marks.

SEMESTER II

		L	T	P	C
P2AMIB06	**COMPOSITE MATERIALS**	**3**	**1**	**0**	**4**

UNIT I FIBRE REINFORCED PLASTICS (FRP) 12

Definition; Types; General properties and characteristics; Reinforcing materials – particles, fibers, whiskers; Properties of reinforcing materials; Matrix materials; Additives; Properties of FRP materials; Automotive applications

UNIT II MANUFACTURING PROCESSES 12

Open mold processes – Hand layup, Spray up, Vacuum bag, Pressure bag & autoclave, Centrifugal casting, Filament winding; Closed mold processes – Compression molding, Resin transfer molding (RTM), Injection molding, Pultrusion; SMC & DMC products, etc.

UNIT III DESIGNING FIBRE REINFORCED PLASTICS 12

Design variables; Selection of fiber-matrix and manufacturing process; Effects of mechanical, thermal, electrical and environmental properties, Fiber orientation, Symmetric and asymmetric structure; Effects of unidirectional continuous and short fibers; Lamination theory; Design equations, Design for failure; FEA design packages; Design examples & case studies in FRP.

UNIT IV ENGINEERING CERAMICS AND METAL MATRIX COMPOSITES 12

Reinforcement materials; Matrix; Characteristics and specialized properties like – weibull modulus, high temperature strengths, wear & frictional property improvements; Selection criteria; Advantages and limitations in use of ceramics & MMCs; Fracture mechanics; Auto applications.

UNIT V CERAMIC & POLYMER METAL COMPOSITES 12

CMC & PMC Characteristics, Various types, Advantages & Limitations, Applications. Role of Mixtures-Reinforcement – Particles – Fibres. Carbon/Carbon Composites- Advantages, Limitations- Sol-Gel techniques – Chemical Vapor Deposits. Composite for automotive applications**.**

TOTAL: 45+15 (Tutorial) = 60 periods

TEXT BOOK

1. Haslehurst.S.E., " *Manufacturing Technology* ", ELBS, London, 1990.
2. Krishnan K. Chawle. "*Composite Material: Science and Engineering*" Second Edition, Springer, 1998
3. T.W.Clyne, P.J. Withers, "*An Introduction to metal matrix composites*", Cambridge University Press, 1993.
4. F.C. Campbell "*Structural Composite Materials*", Materials Park,ASM International,2010

REFERENCE BOOKS

1. Derek Hull, "*An Introduction to composite Materials*", Cambridge University Press, 1988.

2. B.T.Astrom, " *Manufacturing of polymer composites*", Champman & Hall,1997 S.C.Sharma, " Composite Materials", Narosa Publishing House,2000

3. Berins, ISBN 0442010699, "*Design with Plastics and Plastic Engineering*", Wiley & Sons Inc., 1995.

4. D. Huda, M.A. E1 Baradie and M.S.J. Hashmi, "*Metal-matrix composites: Materials aspects- Part II*", Journal of Materials Processing Technology, 37 (1993) 521-541

5. ASM Metals Hand Book, Vol.21, "*Composites*", ASM International, 2001

P2AMIB07 ADVANCES IN MANUFACTURING PROCESSES **L T P C**
3 0 2 4

OBJECTIVE

The objective of this course is to make the students to know and understand the manufacturing process of various Automobile and Component Manufacturing.

UNIT I BULK MATERIAL FORMING **12**

Formability, bending, cupping, redrawing, ironing, complex stamping, metal spinning, stretch forming, fine blanking, high speed blanking.
Unconventional forming processes: High energy rate forming, electromagnetic forming, explosive forming, high speed hot forging, high velocity extrusion, high speed forming machines, peen forming, study of various process parameters.
Numerical Analysis of Material Forming Process

UNIT II BULK MATERIAL SHAPING **12**

Macroscopic plasticity and yield criteria, plastic instability, strain rate & temperature, slab analysis, upper bound analysis, slip line field theory, plastic anisotropy, numerical analysis of material forming processes.
Introduction: Introduction to sheet metal forming lines, sheet- tool-machine tool as a system, properties and grades of sheet metal available, their applications, manufacturing and testing procedure.
Product design for sheet metal: Products manufacturable using sheet metals, formability, analytical prediction of forming limits, strain path, strain distribution, product design for sheet metal forming.
Sheet metal processes: Separating processes like shearing, fine blanking, plasma cutting and bending, laser cutting and bending, bending and springback calculations, bend sequencing, drawing of sheets, draw ratio, LDR, process analysis, process analysis of axysymmetric deep drawn parts.
Special sheet forming processes: Super plastic forming and diffusion bonding processes, sheet joining processes, deformation and weld contours, TWB forming, warm forming, sheet and tube hydro forming, roll forming.
Different types of presses press structures, drives, safety devices,

UNIT III POWDER METALLURGY & SURFACE PREPARATION **12**

General characteristics of metal powders, particle shape flow rate, apparent density, and specific surface are, particle size distribution.
Theory of consolidation, Pressure transmission in powders, compressibility and compatibility of powders, Green strength, Hot isostatic pressing, Powder rolling. Sintering: Mechanisms of Sintering, Factors affecting sintering, activated sintering, liquid phase sintering; Sintering atmospheres; Properties of sintered parts.
Surface Preparation - Basics of Nonferrous Surface: Definitions, names, and types of stainless steel, Aluminum alloy surfaces, Pre-surface preparation, Surface preparation needs for AL and CRES, Surface preparation methods, Steel Surface Preparation: Initial Condition of the Steel Surface, Recognizing & Repairing Surface Imperfections, Recognizing & Removing Surface Contaminants, SSP Dry Abrasive Blast Cleaning Standards. **.** Surface Finish: Surface finish specifications and available standards. Surface finish achieved in various manufacturing processes like metal cutting, Abrasives, Castings, Forming and others non-conventional processes.

UNIT IV JOINING PROCESSES 12

Welding: Fundamentals of welding, Design of weld joint, Welding position & comparison with AWS / EN /ISO standards (Welding machines & types, Applications, Advantages & disadvantages, weld & welding symbols.)
Various welding processes, safety & welding defects (GMAW -MIG/MAG, FCAW, GTAW, SAW & MMAW process; Safety; Welding defects - causes & remedies).
Quality assurance in welding, Requirements of good welding, variables affects the weld quality, Level of imperfections & acceptance criteria, Welding procedure Specification (WPS), Applicable Standards.

Brazing & Crimping: Fundamentals: Flux, Filler materials, Atmosphere; Common brazing techniques. Crimping operation & technique.

Riveting & Mechanical Fastening Processes: Types of rivets, Sizes of rivets, applications joint analysis, various riveting applications in an automobile. Mechanical fastening processes, joining principle (Detachable, conditionally detachable, and un-detachable) with its advantages and disadvantages Mechanical fastening like Integral fasteners, Threaded fasteners, Non-threaded fasteners, and Stapling.

UNIT V NON-TRADITIONAL PROCESSES & RAPID PROTOTYPING 12

Abrasive jet machining, Ultrasonic machining, Electro-discharge machining, Electro-chemical machining and laser beam machining, Automotive applications of Laser welding.

Rapid Prototyping: Product Development Cycle – Data requirements, Modeling, Data representation, part orientation and support, from CAD / CAM, STL format, Slicing, Post Processing. Two-Dimensional Layer – by Layer Techniques- Steriolithography (SL), Solid Foil Polymerization(SFP), Selective Laser Sintering (SLS), Selective Powder Building (SPB), Ballistic Particle Manufacturing (PM), Fused Deposition Modelling (FDM), Laminated Object Manufacturing (LOM), Solid Ground curing (SGC); Direct three Dimensional Techniques: Beam Interference Solidification (BIS), Ballistic Particle Manufacturing, Programmable Moulding, Comparison of GMP characteristics, considerations for adopting RP technology.

TOTAL: 60 periods

TEXT BOOK

1. Heldt. P.M., "High *Speed Combustion Engines* ", Oxford Publishing Co., New York, 1990.
2. Haslehurst.S.E., "Manufacturing *Technology ",* ELBS, London, 1990.

REFERENCE BOOKS:

1. Rusinoff, *"Forging and Forming of metals* ", D.B. Taraporevala Son & Co. Pvt Ltd., Mumbai, 1995.
2. Sabroff, A. M. & Others, *"Forging Materials & Processes* ", Reinhold Book Corporation, New York, 1988.
3. Upton, *"Pressure Die Casting"*, Pergamon Press, 1985.
4. High Velocity *"Forming of Metals* ", ASTME, prentice Hall of India (P) Ltd., New Delhi, 1990.
5. HMT handbook.

P2AMIB08 HEAT TREATMENT OF METALS **L T P C**
3 0 0 3

COURSE OBJECTIVES

This course is designed for the PG students to enhance their knowledge and ability to perform a detailed analysis of heat treatments in order to be able to specify and select materials or to design new applications for materials. It also offers a basic understanding of the process characterization and control that is the basis of computer-aided modeling and optimization of heat treatment practices.

UNIT I PHASE TRANSFORMATION IN STEEL 9

Iron - carbon equilibrium diagram: Transformations on heating and cooling, influence of alloying elements, general principles of heat treatment of steels, isothermal and continuous cooling transformations in steels. Continuous cooling curves TTT and CCT diagrams. mechanism of pearlitic, bainitic and martensitic transformations.

Hardenability – Purpose of Hardenability test, Effects of alloy additions, Jominy end-quench test, Understanding the effect of heating & cooling rate, Effect of quenching in different media, effect of prior microstructures on decomposition of austenite and effects of austenitic grain size, limiting ruling sections for different grades of steel, making of test report, significance of test on component performance.

UNIT II HEAT TREATMENT PROCESSES 9

Annealing, Normalizing, Hardening - retained austenite - measurement and methods of its elimination, hardenability studies- Jominy end quench test, Grossman's experiments. Tempering- Hollomon & Jaffe tempering correlations, Austempering and Martempering, Precipitation hardening, thermomechanical treatment, intercritical heat treatment, other heat treatment processes - splat cooling. Induction and Flame hardening

UNIT III CASE HARDENING 9

Introduction, carburising: principle, carbon potential, mechanism, application of Fick's law, depth of carburization and its control, methods of carburising, heat treatment after carburising, structure, properties and common problems in carburising. Nitriding: introduction, steels used, mechanism, effect of microstructure, white layer, nitriding methods, ion nitriding and nitro-carburising. Induction and flame hardening: principle, methods, operating variables. Measurement of case depth.

UNIT IV HEAT TREATMENT EQUIPMENTS 9

Various heating media used for heat treatment. Temperature and atmosphere control, carburising atmosphere and carbon potential measurement, nitriding gas atmospheres. Quenching media and their characteristics. Various heat treatment furnaces, fluidized bed furnaces, cryo chamber, cryo treatment of steels, sealed quenched furnace, plasma equipment.

UNIT V HEAT TREATMENT OF SPECIFIC ALLOYS 9

Heat treatment of carbon steels, various types of tool steels, high speed steels, maraging steels and die steels. Heat treatment of gray cast irons, white cast irons, malleabilising and S.G.irons, austempering of S.G.Iron. Heat treatment of aluminium alloys. copper alloys and nickel alloys. Defects in heat treated parts: causes and remedies.

TOTAL : 45+15 (Tutorial) = 60 periods

Textbooks

1. Rajan, T. V., Sharma C. P., Ashok Sharma., "*Heat Treatment Principles And Techniques*" Prentice-Hall of India Pvt. Ltd., New Delhi, 2002

2. Vijendra Singh, "*Heat Treatment of Metals*", First edition, Standard Publisher Distributors New Delhi, 1998.

3. American Society for Metals, "*Metals Handbook Vol. 4*", ASM Metals Parks. Ohio, USA, 1991

4. Prabhudev. K H. "*Handbook of Heat Treatment of Steels*", Tata McGraw-Hill Publishing Co., New Delhi, 1988.

5. Novikov,.I., "*Theory of Heat Treatment of Metals*", MIR Publishers, Moscow, 1978

6. Thelning K. E., "*Steel and its heat treatment*", Bofors Handbook, 1975.

P2AMIB09 SELECTIONS OF MATERIALS **L T P C**
3 1 0 4

OBJECTIVES

The objective of this course is to make the students to know and understand the importance of selecting a specific material for a specific job. The subject introduces the properties needed to meet the different working conditions; especially for the automobile industry.

UNIT I INTRODUCTION **12**

Classification of design - Engineering materials and their physical properties applied to design - Selection of material - Factors of safety in design - Endurance limit of material - Determination of endurance limit for ductile material - Notch sensitivity - Principles of design optimization - Future trends - CAD - Euler's formula – Theories of failure - Rankine's formula - Tetmajer's formula - Johnson formula - Design of push - rods –eccentricity loaded columns - Reduction of stress concentration.
Technologically important properties of materials, Physical, Chemical, Mechanical and Electrical properties of metals, Criteria of selection of materials like properties, cost, manufacturing process, availability, legal and safety factors.

UNIT II MATERIALS FOR CORROSION AND WEAR RESISTANCE **12**

Materials for atmospheric, soil, water, acid and alkaline resistance, Corrosion prevention coatings, material for Chemical and Petroleum industries, materials and coatings for wear resistance.

UNIT III MATERIALS FOR HIGH AND LOW TEMPERATURES **12**

High temperature strength and stability, Hot hardness requirements, High temperature steels and super alloys, ductile to brittle transition-HSLA steel, low temperature materials.

UNIT IV MATERIALS FOR AUTOMOTIVE APPLICATIONS **12**

Criteria of selecting materials for automotive components viz cylinder block, Cylinder head, piston, piston ring, Gudgeon pin, connecting rod, crank shaft, crank case, cam, cam shaft, engine valve, gear wheel, clutch plate, axle, bearings, chassis, spring, body panel - radiator, brake lining etc. Application of non-metallic materials like ceramics MMCs for engine components, Polymers and FRPs for exterior and interior.

UNIT V MATERIALS FOR AUTOMOTIVE ELECTRONIC SYSTEMS **12**

Dielectric Materials – Classifications, Organic polymers, Resins, Plastics, Laminated plastics, Elastomers, Ceramics, Inorganic dielectric films. Properties, selection criteria and automotive applications
Conducting Materials – High conduction materials, Superconductors and Hyper conductors, Various Metals and Alloys, Properties, selection criteria and auto applications

Semiconducting Materials – Intrinsic and extrinsic semiconductors, Methods of determining the type of conduction and parameters, Effects of thermal, deformation, radiation and high field on electric conduction, Elemental and compound semiconductors. Properties and auto applications.
On Board level – Powertrain, Engine Management System, Mechatronic: EMS, ABS.
Embedded Electronic systems and Silicon components – Transistors, microprocessors, diodes, ECU, sensors, actuators, communication, power supply, wiring harness
On Vehicle level – Vehicle stability control, Break-by-wire

Traffic Management level – Infotainment, Intelligent transport system

TOTAL: 45+15 (Tutorial) = 60 periods

TEXT BOOKS

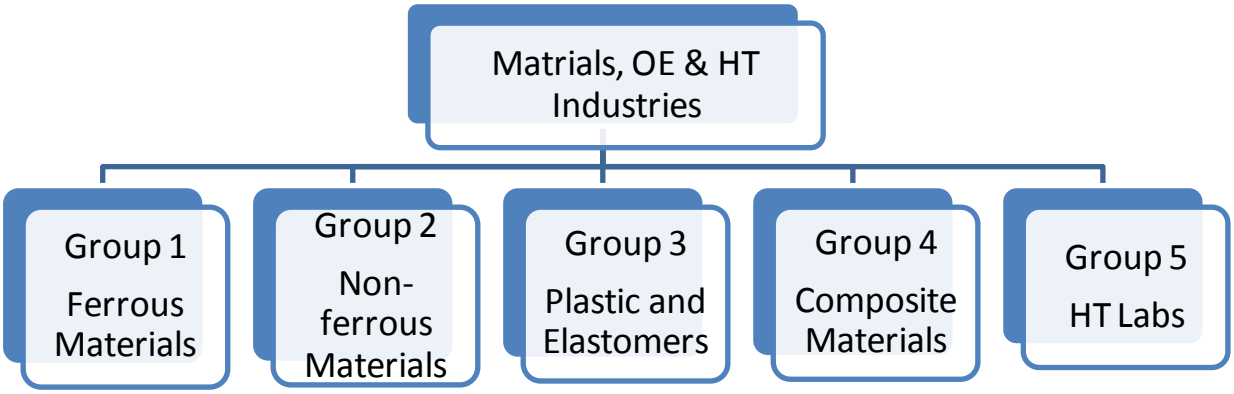
1. Gladius Lewis, "*Selection of Engineering Materials*", Prentice Hall Inc. New Jersey, USA, 1995.

2. Charles J A and Crane. F A.A., "*Selection and Use of Engineering Materials*",3rd Edition, Butterworths, London UK, 1996.

P2AMIB10 **INDUSTRY TRAINING - II** **L T P C**
0 0 6 3

(MATERIALS AND HEAT TREATMENT INDUSTRY)

- Vel Tech to tie-up with AIEMA, Ambattur to pre identify Problems or Tasks to be undertaken with the following types of process industries.



First semester of academics has covered the Automobile engineering, Ferrous & Non-ferrous materials and relevant manufacturing processes and also the Elastomers & Plastics. Students by now are conversant with the Automobile on system, sub-system & component levels. Also, have acquainted knowledge of various automotive materials and manufacturing processes.

In continuation to the study of semester – I, 'Advances in manufacturing processes' is being studied in Sem – II. Application of theory knowledge to select the suitable material within the available resources & facilities will be taught under the course work "Selection of Materials". The student will be preparing report on the similar guidelines.

Industry visits is made in Sem – I, as mentioned under the Lab work of "Industry Problem Solving – I". In this Semester, students also visit to above types of industries. Now student will continue the Industry Problem study in this semester and will further document the following data related to Industry visit:

- **Manufacturing process** sequential operations, activities.
- **Various manufacturing resources** like facilities, machines & equipment's, Infrastructure.
- **The process parameters** like Temperature, Pressure, Electricity required, timing, change in material properties. Also, with the help of Industry expert if not confidential will develop the matrix of process parameters and its effect on material properties & quality. Otherwise will do homework study of the identified manufacturing process from the material and metallurgical aspects, also will carry the literature survey & study the reference books and will develop process parameters map.
- **Problem solving** Learn on industry working, brainstorm with the Industry on completed homework, Literature study, and proposed modifications/suggestions for the alternate solution, hands-on-experiments or visit to identified industry shop floor with the support of industry to Identify & Implement the best alternative practices/processes/solutions or modification in materials or manufacturing. Under this lab work, students will work in Five batches in both semester I & II and

same batch will apply the knowledge accumulated so far to solve the industry problem. Also, it is encouraged to suggest the solution / methodology / change in process parameters or process sequence to existing resources with Industry. All the efforts to solve the manufacturing process problem in Industry should be focused from the perspective of Materials and Metallurgy.

SEMESTER III
AT ARAI, PUNE AND ARAI – FID, CHAKAN

P3AMIB11 - METALLURGICAL FAILURE ANALYSIS **L T P C**
3 1 0 4

Objective

- To provide basic knowledge about the nature of failure of components,
- To introduce methods of identification of mode and causes of failures
- To update the information on recent advances in area of characterization techniques for failure analysis.
- To provide an understanding on systematic procedure for failure analysis, To provide the students with an understanding of the various failure mechanisms in materials and to develop their ability in performing failure analysis of engineering components, through the study and practice on actual engineering failure cases.

UNIT I FUNDAMENTALS OF FAILURE ANALYSIS 12

Importance of failure analysis for automotive components, Steps in typical failure analysis: Collection of background data (review documentation and speak with appropriate individuals), Selection of failed and unfailed samples for examination, Preliminary examination of the failed part, Non-destructive evaluation, Mechanical testing, Macroscopic examination and analysis, Microscopic examination and analysis, Determination of failure mode, Chemical analysis, Fracture mechanics considerations, Full scale testing under service conditions, Analysis of the evidence, Formulation of conclusions, Recommendations to prevent reoccurrence, Sample preparation methods for failure analysis, Selection of locations/samples for failure analysis.

UNIT II INTRODUCTION TO FAILURE ANALYSIS 12

Failure mode identification methods, Failure mechanisms: Fatigue failures, fractography, effect of variables: part shape, type of loading, stress concentration, metallurgical factors, etc. Wear failures, adhesive, abrasive, erosive, corrosive wear. Corrosion failures, types of corrosion: uniform, pitting, selective leaching, intergranular, crevice, etc. Elevated temperature failures, creep, thermal fatigue, micro structural instability, and oxidation.

Causes of failure in components: Misuse or Abuse, Assembly errors, Manufacturing defects, Improper maintenance, Fastener failure, Design errors, Improper material, Improper heat treatments, Unforeseen operating conditions, Inadequate quality assurance, Inadequate environmental protection/control, Casting discontinuities.

Data compilation and identification of root cause.

UNIT III TYPES OF FAILURES IN COMPONENTS 12

Fatigue failures, Corrosion failures, Stress corrosion cracking, Ductile and brittle fractures, Hydrogen embrittlement, Liquid metal embrittlement, Creep and stress rupture .

UNIT IV METHODS AND EQUIPMENT FOR FAILURE ANALYSIS 12

Selection of suitable testing methods for failure analysis

Selection of metallurgical equipments for failure analysis

SEM-EDAX

UNIT V TYPICAL CASE HISTORIES 12

Failure analysis of Leaf Spring, Crankshaft, Universal Joint, Axle, Connecting rod, Piston, Gasket, Propeller shaft, Spring & Suspension.

TOTAL = 45 + 15 (Tutorial) = 60 periods

REFERENCE BOOKS

1. "Understanding How Components Fail" by Donald J. Wulpi; ASM International Publication.
2. "Analysis of Metallurgical Failures: by Vito J. Colangelo; Francis A. Heiser Wiley Publication.
3. ASM Handbook Vol.11 - Failure Analysis and Prevention, ASM International Publication, 1995.
4. "Metallurgy of Failure Analysis" by A K. Das; by McGraw-Hill Professional Publication.
5. Metallurgical Failure Analysis by Charlie R. Brooks; Ashok Choudury; McGraw-Hill Publication.
6. Automotive Component Failures by A. M. Heyes
7. Handbook of Case Histories of Failure Analysis, Vol 2. by A Esaklul Khlefa.
8. Handbook of Case Histories of Failure Analysis, Vol 1 by C.Uhietal Robert.
9. Metallography Principles and Practice by Voort, George F. Vander; ASM International Publication.

P3AMIB12 AUTOMOTIVE MATERIAL TESTING & CHARACTERIZATION L T P C

3 1 0 4

OBJECTIVE

This course is designed for the PG students to enhance their knowledge on importance and significances of material quality in service, their impact on component life, customers' satisfaction in performance. Testing & characterization also significant to meet test standards and laid down specifications, control use of hazardous materials, meet TQM systems. Design engineers need experimental data on material properties for computer-aided modeling to simulate the results of experiments.

UNIT I MECHANICAL TESTS 12

Mechanical Characterization: Mechanical Property characterization- Principles & characterization techniques related to tensile, compressive, hardness, fatigue, and fracture toughness properties. Deformation, Super plasticity

Stress-strain diagram, Determination of YS, UTS, MoE, %E, %RA, Hardness testing, true stress-strain diagram, stretcher strain characteristics, effects of cold working, & n values, poison's ratio, Deep drawn quality of sheets, Impact test, bend test, shear test, Significances of property evaluation, SN curves and fatigue life, non-destructive testing, residual stress measurements, microscopy and scanning electron microscopy, EDAX / WDS analysis, corrosion testing, wear & tear characteristics, slow strain rate characteristics, thermal behaviors.

Thermal Analysis: Principles and applications of thermal analysis.

UNIT II ANALYSIS AND EVALUATION OF PROPERTIES OF PLASTICS, ELASTOMERS AND COMPOSITES 12

Molecular weight distribution, MFI, HDT & VICAT softening point, cold temperature behaviors, Rheological behaviors, hardness and impact properties, identification of polymers, weathering characteristics, cyclic temperature test, flammability, VOC and odor test, scratch resistance test, metal composition analysis, RoHS analysis

Electrical properties of Materials – Dielectric constant, electrical resistivity, coefficient of thermal expansion & contraction, wire harness test

Automotive Electronic Functional Tests

-

Testing for Automotive Electronic Modules – Powertrain (Engine and Transmission control), Body, Airbag, ABS

- Computing and I/O (LAN / USB / GPIB)
- Serial Communication (CAN, LIN, ISO 9141)
- Low frequency Stimulus instrumentation (D/A, Arbitrary waveform)
- Low frequency measurement instrumentation (DMM, Digitizer)
- Load and stimulus / measurement switching
- Device under test (DUT) DC Power
- Mass Interconnect

UNIT III ANALYSIS OF FUELS, LUBRICANTS AND FLUIDS 12

Physico-chemical properties of Petrol, Diesel, LPG, CNG, and Bio-fuels, specifications of fuel quality to meet Bharat stage III, IV and future emission norms, Significance of properties & their effects.

Lubricants (oil & greases) used in different part of 2, 3, 4 or heavy vehicles like brake, gear box, engine lubrication, differential etc. types & classes. Physica-chemical characteristics: failures due to quality of these lubricants.

Brake fluids, Anti freeze engine coolents, Auto Transmission fluids – Physico-chemica properties as per National & International standards, approval tests, significance of various properties, corrosive effects on radiators & remedial solutions.

UNIT IV INSTRUMENTAL TECHNIQUES 12

FTIR spectrometer, Thermal analyzer, X-ray analyzer, Optical emission spectroscopy, Ion Chromatography, Gas and Liquid Chromatography, High strain rate tester, Non-destructive instruments, etc.

New innovations in testing and characterization, X-ray Diffraction, Electron microscope (SEM, TEM), Scanning probe microscopy (SPM, AFM), Spectroscopic methods (EDS, FTIR); Mechanical behaviors, Thermal response, Fire retardancy, Chemical resistance and Electrical-Magnetic-Optical properties of ploymer nano-composites;

UNIT V QUALITY CONTROL 12

Testing & validation of materials & components, National & International specifications, Safety and environment impacts, ISO 9001, TQM, OSHA standards.

Characterization strategy: 1) What and why of it 2) Problem analysis 3) Technique selection 4) Modeling the results 5) Data analysis & issues 6) Characterization experiments

TOTAL = 60 periods

TEXT BOOKS

Dictionary of Materials and Testing, Second Edition by Joan Tomsic

REFERENCE BOOKS

1. Automobiles & Pollution by Degobert Paul, 1995
2. Alternative Fuels – Transportation fuels for Today and Tomorrow by Richard L. Bechtold
3. Improving Air Quality – Progress and Challenges for Auto Industry by John K. Pearson
4. The Automotive Industry and The Global Environment by Cervis Schuttle
5. Emissions and Air Quality by Hans Peter Lenz and Cristian Cozzarini
6. Alternate Fuels Guidebook – Properties, Storage, Dispensing and Vehicle facility Modifications by Richard L. Bechtold Richard L
7. Alternative Fuels: Emissions, Economics and Performance by T. T. Maxwell, Jesse C. Jones, Society of Automotive Engineers, 1995.
8. Material Characterization: Introduction to Microscopic & Spectroscopic Methods by Yang Leng John Wiley & Sons (Asia) Pte Ltd.
9. ASM Handbook on Metals Handbook: Vol. 8 Mechanical Testing – 1978.

P3AMIB13 ADVANCES IN AUTOMOTIVE MATERIALS AND PROCESSES L T P C
3 1 0 4

OBJECTIVES

The syllabus is designed to give insight into emerging metallic and non-metallic materials such as – high strength steels, natural fiber composites, smart materials & structures for use in modern vehicles with respect to their multifunctional properties and eco-friendly nature.

UNIT I HIGH STRENGTH STEELS 12

Bake hardening (BH) grades, Isotropic steels, Interstitial free (IF) grade steels, Rephosphorized steels, High strength micro alloy steels, Dual phase steels, TRIP steels, Boron steels, Multiphase steels, AHSS grades – Austenitic SS, L-IP, TWIP; Hydroforming process, Auto applications and future

UNIT II NATURAL FIBER COMPOSITES 12

Automotive needs for use of natural fiber composites, Natural fiber classification – Bast fibers, Leaf fibers, Sead fibers, Fruit fibers, Wood fibers; Fiber properties; TS & TP composites with NFs and their properties; Automotive applications

UNIT III SMART MATERIALS 12

Introduction - Definition of Smart Materials, Functional properties that lead to their consideration; Piezoelectric materials, Electoactive materials, Shape memory alloys (SMA), Optical fibers, Nano-composites – defination, types.

Nano-composites – Materials and Processes

Mechanisms, Structure-property relationship, Basic classes – TP, TS, Elastomers and blends; Forms – Fibers, Foams, Film, Membranes and Paints; Geometric forms – Nanospheres (clay), Nanotubes (Single & multi wall) & Nano fibers, and Nanoplatelets; Importance of interface between matrix and nanophase; Functionalization; Production of Nano-composites – Melt processes, Solution processes, In-situ processes and other processes.Applications and future trends – Automobiles, Coatings, Adhesives, Fire retardants, Micro-electronic packages, Optical integrated circuits, Sensors, Membranes, etc.

UNIT IV NOISE, VIBRATION AND HARSHNESS MATERIALS 12

NVH Materials: Defination of NVH, fundamentals of propagation of noise and vibrations, NVH measurement techniques, Sources of noise in vehicle, evaluation of acaustic parameters, noise and vibration effects on automotive applications, active noise control, Modal analysis, Modeling of material properties in CAE.

Design of materials and properties for NVH control – Elastomers, Composites, Woven fabrics, Sandwich materials, Transducer materials, Dampers and Absorbers, Injection molded barriers, Adhesives, sealants

and foams, smart materials, Intelligent material systems, case studies for selection of NVH materials – Pasby noise, Exterior noise, Cab (Interior) noise, Suspension system noise, Engine noise, Inlet / Exhaust noise

UNIT V MEMS 12

Introduction - **Materials for MEMS manufacturing** - Silicon-Polymers-Metals-**MEMS basic Processes** - **Deposition process**-Physical Vapor Deposition ,Chemical Vapor Deposition – **Patterning**-Lithography-Photolithography, Electron beam Lithography, Ion Beam lithography ray Lithography, Diamond Patterning - **Etching Processes**: **Wet etching**-Isotropic etching, Anisotropic etching-HF etching-Electrochemical etching, **Dry etching**-Vapor etching**-**Xenon difluoride etching-**Plasma etching**-Sputtering, Reactive ion etching(RIE) - **Die preparation** - **MEMS manufacturing Technologies** - Bulk micromachining, Surface micromachining, High aspect ratio(HAR) silicon micromachining –**Applications**

TOTAL = 60 periods

REFERENCE BOOKS

1. L. S. Srinath, Experimental Stress Analysis, Tata McGraw Hill, 1998
2. J. W. Dally & W.F. Riley, Experimental Stress Analysis, Tata McGraw Hill, 1998
3. Friedrich, Fakirov & Zhang, "Polymer Composites from Nano to Macro scale"; Springer, 2005
4. Ray & Bousmania, "Polymer Nanocomposites and their Applications"; ASP 2006
5. Advani, "Processing and Properties of Nanocomposites" World Scientific, 2007
6. Mikitaev, Kozlov & Zaikov, "Polymer Nanocomposites"; Nova Publishers, 2008

P3AMIB14 SOFT SKILLS **L T P C**
2 0 2 3

Objectives

- This course aims to polish the skills of the students like a diamond.
- Teach Etiquettes and Ethics to improve his overall branding
- Reinforce passion, team work and communication skills
- Prepare him to be ready to face the corporate world and be successful.

UNIT I INTRODUCTION **12**

Introduction to Soft Skills, Personality Development and Human Values, Self Awareness & Esteem, Perception and Attitudes, Self Assessment & SWOT Analysis, Career Plan & Personal Goal setting, Building Personal Brand, Johari Window and Leadership.

UNIT II COMMUNICATION AND SKILL BUILDING **12**

Communication Skills, Verbal Communication, Written communication, Body Language, Event Management, How to write Report & SAE Papers, Paper Review, Book Review, Presentation, Intelligence Building, Emotional Quotient, Intelligence Quotient & Memory Improvement, Cracking Written tests, Interviews & Group Discussions.

UNIT III ETHICS AND ETIQUETTES **12**

Professional Ethics & Etiquettes, Business Ethics, Corporate Ethics, Engineering Ethics, Office Etiquettes, Email Etiquettes, Telephone Etiquettes, Lunch/Dinner Etiquettes Social and Public Etiquettes.

UNIT IV SOFT SKILLS AT WORKPLACE **12**

How an Industry Works, Various Departments of Industry, Industry Review, Team building & Motivation, Auto Passion, Confidence Building, Product Development Cycle, Customer Satisfaction & Quality Function Deployment (QFD), Benchmarking, Design for Failure Mode Effects Analysis (DFMEA), Design Review, Vehicle Review.

UNIT V BUSINESS/WORK SUCCESS **12**

Time Management, Interpersonal Skills, Negotiation Skills, Delegating Skills, Executive Summary & Business Report, Handling of Difficult People, Business Analysis, Business Strategy, Meeting Skills, Stress Management & Meditation, Knowledge Management, Project Management, Performance Management System, Total Quality Management.

TEXT BOOKS FOR SOFT SKILLS

1. Narian Ram, Twelve Management Sills for Success, Viva Books, 2006.
2. Dr Bond Allan, Your Masters Thesis, Viva Books, 2006.
3. Verity Judith, Succeeding at Interviews, Viva Books.
4. High Jana L., High Tech Etiquettes, Viva Books.
5. Haynes Marion E., Effective Meeting Skills, Viva Books.

REFERENCE BOOKS FOR SOFT SKILLS

1. ARAI & SAEINDIA W.S. Proceedings, 3 Day Certificate Course on Quality Function Deployment
2. ARAI & SAEINDIA W.S. Proceedings, 3 Day Certificate Course on Design Failure Mode & Effect Analysis.

P3AMIB15 **PROJECT MANAGEMENT** **L T P C**
2 1 0 3

OBJECTIVES

- To introduce to the students the basics of project management and need for it;
- To teach the students various project management processes, knowledge areas and tools & techniques for the same;
- To teach the students to use MS Project software tool for project management; and
- To prepare students to use this knowledge of project management and tools for their academic projects.
- **Note:** This course is based on the book 'A Guide to the Project Management Body of Knowledge' by Project Management Institute, USA since it provides a basic reference to learn project management knowledge and practices in a very structured way with a focus on tools and techniques. By doing so, this course will also prepare the students and provide opportunity for them to take up the institute's professional development programme in future, if they choose so, besides fulfilling the objectives stated above.

OUTCOME

On completing the course, students would have

- Learnt the basics of project management, various processes and knowledge areas of it and tools and techniques required therein;
- Acquired skills of using MS Project software tool for project management; and
- Developed project charter and plan for their academic projects.

UNIT I THE PROJECT MANAGEMENT FRAME WORK 05

Introduction: What is a project? What is project management? Relationship to other management disciplines.
The project management context: Project phases and life cycle, project stake holders, organizational influences, key general management skills, social-economic-environmental influences
Project management processes: Project processes, process groups, process interactions, customizing project processes, mapping project management processes.

UNIT II THE PROJECT MANAGEMENT KNOWLEDGE AREAS 14

Project integration management: Project plan development, project plan execution, integrated change control.
Project scope management: Inititiation, scope planning, scope definition, scope verification, change control.
Project time management: Activity definition, activity sequencing, activity duration estimating, schedule development, schedule control.
Project cost management: Resource planning cost estimating cost budgeting, cost control.
Project quality management: Quality planning, quality assurance, quality control
Project human resource management: organizational planning, staff acquisition, team development.
Project communication management: Communication planning, information distribution, performance reporting, administrative closure.

Project risk management: Risk management planning, risk identification, qualitative risk analysis, quantitative risk analysis, risk resource planning, risk monitoring and control.
Project procurement management: Procurement planning, solicitation planning, solicitation, source selection, contract administration, contract closure.

UNIT III PROJECT MANAGEMENT CASE STUDIES 04

Case study 1: on automotive industry project on product development by invited expert.
Case study 2: on non automotive industry project or automotive industry project other than product development by invited expert.

UNIT IV LEARNING MS PROJECT SOFTWARE TOOL 10

UNIT V DEVELOPING PROJECT CHARTER AND PLAN FOR ACADEMIC PROJECT 07

Need, purpose, outcome and methodology of selection and implementation of academic projects. Recap of learning so far of project management processes and knowledge areas, tools and techniques in the view of application for academic projects.
Development of project charter and plan for academic project, students presentations on their project plans, simulated class exercise on a typical academic project.

TOTAL: 45 periods

REFERENCES

1. A Guide to the Project Management Body of Knowledge' by Project Management Institute, USA.
2. Microsoft Office Project Manual

P3AMIB16 METAL FORMING SIMULATION LAB **L T P C**
2 0 2 3

OBJECTIVES

Provide hands-on knowledge and experience on metal forging simulation packages which engineer would need to understand design rules, importance of CAE in modeling and manufacturing of components, so as to optimize material and total life cycle cost in the given set of industry infrastructure.

The course is divided in to theory lectures and simultaneously training in the laboratory on simulation software packages, do practicals taking live case study.

Introduction to Metal Simulation Procedure: Understanding inputs required for correct simulation.

1. Unit I: Pre-Processing (GLpre) 5 hrs
   - 1.1. Creating a new project
   - 1.2. Geometries loading
   - 1.3. Meshing the geometries
   - 1.4. Positioning the billet & dies
   - 1.5. Measuring meshes quality
   - 1.6. Symmetry planes
   - 1.7. Billet Properties
   - 1.8. Dies initial settings
   - 1.9. Machine kinematics
     - 1.9.1. Global parameters definitions
     - 1.9.2. Defining marking grids
     - 1.9.3. Die stress analysis simulation
2. Unit II: Computation (Solution) 5 hrs
3. Unit III: Post-Processing (GLview Inova) 5 hrs
   - 3.1. Part results (Scalars & Vectors)
   - 3.2. Part results - Advanced (Scalars & Vectors)
   - 3.3. Die results (Scalars & Vectors)
   - 3.4. Marking Grids & Graphs

LIST OF PRACTICAL: (10hrs.X3)

Based on following subjects students of batch 2 will perform any of the three practical from following:

1. Spindle Problem: Students will perform pre-processing, solution & post processing of tutorial spindle. The problem is to set up and compute a simulation of the forging of a spindle in two stages. In addition, a die stress analysis in the upper die will be also described. With the given as the geometries of the two sets of dies (upsetting and blocker), as well as the initial billet geometry have already been defined in a CAD package and available as meshed surfaces using STL format (dimensions in mm). For the demonstration purpose, the dies are not in correct initial position and the mesh size is not appropriate. As the final part owns 2 symmetry planes and just simulates the forging process of a 1/6th of complete model. The outcome from the study is to measure die stresses, temperatures, displacements, under fill, fold and cracks.

2. Optimization: Automatic optimization of a material forming processes in particular forging. Students can submit their material forming problem directly to the software application, by choosing the criteria to be optimized and the variables to be modified. The outcome of this study is that optimization can be used to reduce the weight of a slab taking filling constraints into

account, to minimize forging load, to obtain precise shapes, to improve the soundness of the material, etc.

3. Cogging (Open Die Forging): Cogging is an open die forging process. It is used in order to change billet properties before forging (shape, mechanical and microstructural properties). Process consists of several bites between two dies (usually more than 500 bites). The outcome of this study is to prepare a template for open die forging which also includes pre-defined objects to represent the use of manipulators and defining multi pass file.

4. Cold forging of Valve Housing: Forge simulation permits to detect the major defects like folds or under fills in the forging process. Thus, it is possible to avoid these defects before starting the real trials or to correct the design of a current faulty design. Students will perform pre-processing, solution & post processing of tutorial valve housing. The outcome from the study is to measure die stresses, temperature, displacements, under fill, folds and cracks.

NOTE: Batch of 2 students will be assigned Practicals / Case studies independently to do Practicals

TEXT BOOKS

1. Practical Finite Element Analysis by Nitin S Gokhale et al, January 2008
2. ASM Handbook Volume 22A: Fundamentals of Modeling for Metals Processing
3. Metal Forming and Finite-element Method by Shirō Kobayashi, Soo-Ik Oh, Taylan Altan, Oxford University Press
4. Metal Forming Analysis by Robert H. Wagoner, J. L. Chenot, Cambridge University Press
5. Numerical Simulation of Casting Solidification in Automotive Applications
6. Handbook of Die Design by Ivana Suchy, McGraw Hill Professional Mechanics of Sheet Metal Forming edited by Jack Hu Zdzislaw Marciniak, Technical University of Warsaw John Duncan
7. Software suppliers' guide-line books / Manuals.

P3AMIB17 AUTOMOTIVE MATERIALS & CHEMICAL LAB **L T P C**

0 0 6 3

1. Analysis of Carbonyl Compound from Exhaust Emission using hplc.
2. Chemical Characterization of Gasoline Fuel.
3. Chemical Characterization of Diesel Fuel.
4. Chemical Analysis of Metals.
5. Hardness Testing (Rockwell, Brinell, Vickers).
6. Micro-Hardness testing.
7. Tensile testing on a metal specimen.
8. Residual Stress Measurement, Analysis and Calibration with stress free material.
9. Magnetic Particle testing.
10. Micro-structural studies of ferrous / Non-ferrous material.

SEMESTER IV

PROJECT / DISSERTATION WORK
AT ARAI-FID AND OR INDUSTRY SPONSORED

		L	T	P	C
P4AMIB18	**PROJECT WORK**	**0**	**0**	**32**	**16**

OBJECTIVES

1.To teach students to apply creative and critical thinking skills.
2.To enable the students to develop a proto type or working model for the solution of a real-time problem.
3.To enable them to improve practical working skills and foster collaborative learning skills.
4.To help the students develop self-directed inquiry and life-long learning skills.
5.To involve the students in the actual design and development of the end-product or project proto type.
6.To enable them to analyze the data critically & conclude.
7.To enable them to achieve quantifiable measurable targets.

OUTCOME

Student will be able to
1.Improve creative and critical thinks skills.
2.Solve a real time problem on the basis of governing methods or equations.
3.Involve in the development of the end-product or project proto type.
4.Present paper or file patent.
5.Implement the project.

The project work should preferably be live problem in industry or a micro issue having a bearing on performance of the automobile industry and should involve scientific research, design, generation/collection and analysis of data, use of software's, determining solution and must preferably bring out the individual contribution. The dissertation should be presented in standard format. The viva-voce shall be conducted with the help of approved external examiners.

The M. Tech. project would be evaluated in 3 phases to totaling to 500 marks.

Phase 1: Marks out of 50 given by Reporting Guide. The marks distribution will be as follow:

1.Project plan	(10 marks)
2.Presentation	(10 marks)
3.Attendance/ Punctuality	(10 marks)
4.Daily Targets	(10 marks)
5.Project progress	(10 marks)

Phase 2: Marks out of 100 jointly given by Reporting Guide, Academy Faculty & University Faculty. The marks distribution will be as follow:

1.M.S. Project Tracking / Adherence	(10 Marks)
2.Literature / Patent Review	(15 Marks)
3.Quality/Quantity of work till date	(15 Marks)
4.Presentation (Slides & Style)	(20 Marks)
5.Knowledge & Understanding (Q&A)	(20 Marks)
6.Results & Scope for further work	(20 Marks)

Phase 3: Marks out of 350 jointly given by External & Internal examiners for Viva-Voce. The marks distribution will be as follow:

1.M.S. Project Tracking / Adherence	(20 Marks)
2.Quality of Work	(50 Marks)
3.Results / Analysis / Conclusions	(50 Marks)
4.Quality of Project Report	(50 Marks)
5.Quality of Presentation (slides & Style)	(50 Marks)
6.Knowledge and Understanding (Viva, Q & A)	(50 Marks)
7.Experimental Validation	(20 Marks)
8.Paper Publication & Intellectual Property	(20 Marks)
9.Implementation of Project	(20 Marks)
10.Feedback / Submission of Report	(20 Marks)

All the students have to submit Project Proposal Sheet duly signed by Guide & HOD before commencement of project as per format given here.

Students Project Proposal for M.Tech. Programme			
1.		**Project Title**	
2.		**Industry / Institute**	
3.		**Project Duration**	
4.		**Project Category**	
4.1	a)	Is it a new test rig development project?	
	b)	Is it R&D (capability development) Project?	
	c)	Is it Technology development project?	
	d)	Is it Software related project?	
	e)	Is it Design/Optimization project?	
	f)	Is it Testing & evaluation project?	
4.2	a)	Is it already a part of an on-going or an approved, or a prioritized project?	
	b)	Is it A Plan/Cess/DST/Sponsored project?	
5.		**Related Standards, Regulations, Reference Literature, if any**	
6.		**Objectives & Target of the Project**	
7.		**Need and Justification**	
8.		**How your Department is capable of taking up this Project?**	
	a)	Existing facilities / infrastructure	
	b)	Competences/ experience	
	c)	Studies conducted / publications, if any	
9.		**Monthly Stipend**	
10.		**Remarks**	

Signature:

	Student	Industry Guide	Industry HOD	Academy Guide	Academy HEAD
Name					
Designation					
Department					
Mobile No.					
Email ID					

PEAMIB19 DESIGN OF EXPERIMENTS & OPTIMIZATION TECHNIQUES L T P C
3 1 0 4

OBJECTIVE

The study of materials and manufacturing is concerned with the optimum use of materials, energy, time and individual effort to serve effectively the needs of the industry through the design of systems of machine structures and through better understanding of various processes involved in these systems. So, it is aimed that a post graduate programme in materials and manufacturing engineering should include topics of design of experiments and optimization techniques. Accordingly, this paper is designed to include the study of experimental designs and optimization techniques.

UNIT I ANOVA & DESIGN OF EXPERIMENTS 12

Analysis of Variance and its meaning- one-way classification- two-way classification.
Basic principles of design of experiments (replication, randomization and local control)- CRD- RBD- LSD.

UNIT II FACTORIAL EXPERIMENTS & TAGUCHI APPROACH 12

Factorial experiments and their need- 2^3 and 3^2 Factorial Experimental Designs without confounding (Theory and Problem only, no derivation expected).
Taguchi Approach: Parameter Design, Robust Design

UNIT III OPTIMIZATION TECHNIQUE BY SEARCH METHOD 12

Optimal problem formulation -Boundary phase method – Fibonacci search method – Golden section search method – Powell's conjugate direction method – Conjugate gradient method – Variable-metric method.

UNIT IV ALGORITHMIC OPTIMIZATION TECHNIQUE 12

Kuhn-Trucker conditions – Penalty function method – Frank-Wolfe method – Generalized reduced gradient method – Generalized projection method.

UNIT V OPTIMIZATION TECHNIQUE BY GENETIC ALGORITHM 12

Genetic algorithms(GAs) - working principle – difference between GAs and the traditional methods – GAs for constrained optimization – Simulated annealing – Global optimization: using steepest descent method and GA.

Total = 60 periods

REFERENCE BOOKS

1. Cochran, W.G. and Cox, G.M.: Experimental Designs, 2nd Edition, John Wiley & Sons, Inc, 1957.
2. Davis, L.: Handbook of genetic algorithms, Van Nostrand Reinhold, 1991.
3. Deb, K.: Optimization for engineering design, Prentice Hall of India, 2005.
4. Montgomery, D. C.: Design and Analysis of Experiments, John Wiley & Sons, 1984.
5. Phadke, M. S: Quality Engineering using robust design, Prentice Hall, 1989.
6. Philip, R. J.: Taguchi Techniques for quality engineering, McGraw Hill, 1989.
7. Rao, S.S.: Optimization theory and applications, Wiley Eastern, 1984.

PEAMIB20 APPLIED TRIBOLOGY **L T P C**
3 1 0 4

OBJECTIVES

To familiarize engineering students with the basic concepts of tribology which would be useful in choosing and designing various tribological machine elements like bearings, gears, valve train and piston assemblies of automobile engines.

- Understanding the principles for selecting compatible materials for minimizing friction and wear in machinery.
- Understanding the principles of bearing selection and bearing arrangement in machines.
- Learn the computations required for selecting and designing bearings in machines.
- Understanding the fundamental principles of lubrication for reduction of friction and wear.
- Understanding the fundamental principles of high contact stresses (Hertz stresses), fatigue-failure, and Elastohydrodynamic (EHD) lubrication in rolling bearings and gears.

UNIT I SURFACES, FRICTION AND WEAR **12**

Topography Of The Surfaces - Surface Features Of Metal And Composites - Surface Interaction – Definition of Friction- Laws of Friction - Friction Properties Of Metallic, Ceramic, Polymer and lamellar solid materials– Wear- Types of Wear – Archard Wear Equation - Wear of brass-unlubricated wear of metals-wear regime maps for metals-Mechanism of Adhesive – Abrasive wear equation- Mechanism of Abrasive wear – particles properties: hardness, shape and size- Wear Resistance Materials – Wear testing methods.

UNIT II LUBRICATION THEORY **12**

Lubricants And Their Physical Properties - Lubricants Standards - Lubrication Regimes Hydrodynamic Lubrication - Reynolds Equation, Thermal, Inertia And Turbulent Effects - Elasto Hydrodynamic and Plasto Hydrodynamic And Magneto Hydrodynamic Lubrication - Hydro Static Lubrication - Gas Lubrication. – Stirbeck Diagram.

Design And Performance Analysis Of Thrust And Journal Bearings – Slide Bearing - Full, Partial, Fixed And Pivoted Journal Bearings Design - Lubricant Flow And Delivery - Power Loss, Heat And Temperature Rotating Loads And Dynamic Loads In Journal Bearings - Special Bearings - Hydrostatic Bearing Design.

UNIT III ROLLING ELEMENT BEARINGS **12**

Geometry And Kinematics - Materials And Manufacturing Processes - Contact Stresses - Hertzian Stress Equation - Load Divisions - Stresses And Deflection - Axial Loads And Rotational Effects, Bearing Life Capacity And Variable Loads - ISO Standards - Oil Films And Their Effects - Rolling Bearings Failures, Needle bearing.

UNIT IV TRIBO MEASUREMENT IN INSTRUMENTATION **12**

Surface Topography Measurements –Assessment Statically Methods –Stylus Profilometers - Optical Microscopy - Scanning Electron Microscope – Transmission Electron Microscopy – AFM – XPS – EDX – XRD – hardness measurement – micro hardness – nano indentation - Instrumentation – Wear Measurements – Wear Debris Analysis - Bearings Performance Measurements

UNIT V ENGINE TRIBOLOGY **12**

Introduction – Modified Stribeck Curve for Engine Components – Fuel Energy Distribution of Engine Components – Tribological Engine Components: Friction and wear - Piston Assemblies: Surface topography, wear prediction – Valve Train: Surface Roughness, wear prediction, waviness – Engine Bearings: Asperity Interaction, journal waviness, bearing with microgrooves, wear prediction – Design modification of Engine components.

TOTAL: 45+15 (Tutorial) = 60 periods

REFERENCE BOOKS

1. Bowden, F.P. & Tabor, D., "Friction And Lubrication Of Solids", Oxford University Press 1986
2. Ernest Rabinowie z, " Friction And Wear Of Materials" Inter science Publishers, 1995
3. Neale, M.J., Tribology – Hand Book, Butterworth, 1995.
4. Fuller D.D., Theory And Practice Of Lubrication Of Engineers:. John Wiley Sons, 1984
5. Cameron, A. "Basic Lubrication Theory", Ellis Herward Ltd. Uk,1981.
6. Hulling, J. (Editor) --"Principles Of Tribology", Macmillan,1984.
7. Williams J.A. "Engineering Tribology", Oxford Univ. Press,1994.
8. Neale M.J, "Tribology Hand Book ", Butterworth Heinemann, 1995.
9. Bhushan. B. Modern Tribology Handbook, Volumes 1 & 2. - Boca Raton A.O.: Crc Press, 2000. – 1760 P.
10. Stachowiak G., Batchelor A.W. Engineering Tribology. - New York A.O.: Butterworth-Heinemann; 2001. – 744 P.
11. Garkunov D.N. Scientific Discoveries in Tribo-Technologies. No-Wear Effect under Friction. Hydrogen Wears of Metals. - Moscow: Maa Publishing House; 2007. – 383 P.

PEAMIB21 MEASUREMENTS AND INSTRUMENTATION SYSTEMS **L T P C**
3 1 0 4

AIM

To enhance the knowledge of the students about various measuring instruments, techniques and importance of error and uncertainty analysis. To provide knowledge on various measuring instruments, advance measurement techniques and to understand the various steps involved in error analysis and uncertainty analysis**.**

UNIT I MEASUREMENT CHARACTERISTICS **9**

Instrument Classification, Characteristics of Instruments – Static and dynamic, experimental error analysis, Systematic and random errors, Statistical analysis, Uncertainty, Experimental planning and selection of measuring instruments, Reliability of instruments.

UNIT II MICROPROCESSORS AND COMPUTERS IN MEASUREMENT **9**

Data logging and acquisition - use of sensors for error reduction, elements of micro-computer interfacing, intelligent instruments in use.

UNIT III MEASUREMENT OF PHYSICAL QUANTITIES **9**

Measurement of thermo-physical properties, instruments for measuring temperature, pressure and flow, use of sensors for physical variables.

UNIT IV ADVANCED MEASUREMENT TECHNIQUES **9**

Shadowgraph, Schlieren, Interferometer, Laser Doppler Anemometer, Hot wire Anemometer, heat flux sensors, Telemetry in measurement.

UNIT V MEASUREMENT ANALYSERS **9**

Orsat apparatus, Gas Analysers, Smoke meters, gas chromatography, spectrometry.

TOTAL: 45 periods

TEXT BOOKS

1. Holman, J.P., Experimental methods for engineers, McGraw-Hill, 1988.
2. Barney, Intelligent Instrumentation, Prentice Hall of India, 1988.
3. Prebrashensky, V., Measurements and Instrumentation in Heat Engineering, Vol.1 and 2, MIR Publishers, 1980.

REFERENCE BOOKS

1. Raman, C.S., Sharma, G.R., Mani, V.S.V., Instrumentation Devices and Systems, Tata McGraw Hill, New Delhi, 1983.
2. Doeblin, Measurement System Application and Design, McGraw Hill, 1978.
3. Morris.A.S, Principles of Measurements and Instrumentation, Prentice Hall of India, 1998.

PEAMIB22 ENGINEERING RELIABILITY OF MATERIALS **L T P C**
4 0 0 4

OBJECTIVE

To provide complete set of summarized Context of the Engineering Reliability process for Materials with updated application oriented version syllabus. In this all important elements covered in Sequential and technical manner.

UNIT I INTRODUCTION TO ENGINEERING RELIABILITY **12**

Definition of Reliability function, failure rate, Failure density, Hazard density, Reliability Data Analysis- Time-to-failure distributions - Exponential, normal, Gamma, Weibull, ranking of data - probability plotting techniques - Hazard plotting, measures of performances, Reliability, Availability, and Maintainability.

UNIT II MECHANICAL BEHAVIOR OF MATERIALS **12**

Plastic deformation in poly phase alloys - Strengthening mechanisms - Griffith's theory of failure modes – Brittle and ductile fractures - Damping properties of materials - fracture toughness - Initiation and propagation of fatigue cracks - Creep mechanisms - Hydrogen embitterment of metals, Selection of materials for various applications.

UNIT III DESIGN RELIABILITY OF AUTOMOTIVE MATERIALS **12**

Basic properties, measured of properties, Reliability Tests- Issues on mechanical properties Evaluation-related to specimens, test apparatus,, mechanical properties usability of materials, measurements method- ASTM,Afera,IEC,ISO,UL Standards, Specification model.

UNIT IV MECHANICAL RELIABILITY **12**

Introduction, Reasons for the Discipline of mechanical Reliability & mechanical failure modes, safety factor &safety margin, design by reliability methodology & stress-strain models, mellin method.

UNIT V RELIABILITY TESTING & GROWTH **12**

Introduction, Reliability Testing- classifications, Success testing, Confidence Interval estimates for mean time between Failures, accelerated life testing. Reliability Growth – Growth program, growth process evaluation approaches, growth models, Duane model, Army material system analysis activity model.

Total = 60 periods

REFERENCE BOOKS

UNIT I

1. John Davidson, "The Reliability of Mechanical system ", Institution of 3.
2. Mechanical Engineers, London, 1988. C.O. Smith" Introduction to Reliability in Design ", McGraw Hill, London, 1976.
3. PB Venkataraman, Srinath Reliability Engineering Text book.

UNIT II

1. Dieter,G.E., Mechanical Metallurgy, MC Graw –Hill 3rd Edition, New York.
2. Aver, S.H., Introduction to physical metallurgy Mc Graw Hill, New York,1982.
3. Bava H.S Materials metallurgy Principle & Practice, Preventive, Hall 1995.
4. Callister W.D. (2006) "Material Science and Engineering- An introduction", Wiley –Eastern.
5. Raghavan, V., (2003) "Physical Metallurgy", Prentice Hall of India.
6. Thomas H. Courtney, (2000) "Mechanical Behavior of Materials", McGraw Hill,.
7. Flinn R. A. and Trojan P. K., (1999)"Engineering Materials and their Applications", Jaico.

UNIT III

1. Dieter,G.E., Mechanical Metallurgy, McGraw –Hill 3rd Edition, New York.
2. Aver, S.H., Introduction to physical metallurgy McGraw Hill, New York,1982.
3. Bava H.S Materials metallurgy Principle & Practice, Preventive, Hall 1995.
4. Blazej, D. 2003 thermal Interface Materials, Electronics Cooling. Novemeber 2003.7p.
5. Bromanco-Bjorkgren AB.2006.Graf Revolutionerar Varmearledning. Electronix Scandinavia 2006 Goteborg Masskatalog. September 2006,PP.12-13.
6. Lasance, C.J.M 2003.Problems with thermal Interface material measurements: Suggestions for improvement Electronics Cooling, Vol 9,No-4,PP.22-2.
7. Afera, ASTM, IEC, ISO, UL, Standards.

UNIT IV

1. Mechanical Reliability Improvement: Probability and Statistics for Experimental Testing by D.M. Kosikowski (Kindle Edition - Apr. 17, 2007) - Kindle eBook
2. Dhillon B.S.,mechanical reliability:Theory models & Applications ,American Institute of Aeronautics &Astronautics,Washington,D.C.,1998.
3. Grant Ireson, W., Coombs, C.f., and Moss, R.Y., Hand Book of reliability engineering and management McGraw-Hill, New York,1996.
4. Methods for Statistical Analysis of Reliability and Life Data, Mann, N.R. Schofer R.E. & Singpurwalla, N.D., Wiley, New York
5. Statistical Analysis of Reliability and Life- Testing Models, Bain, L.J, Dekker, New York,

UNIT V

1. MIL-HDBK-781,Reliability Test methods, plans & Environments for Engineering Development, Qualification and production, Department of Defence ,Washington D.C.
2. Bain L.J and Engelhardt, M., Statistical Analysis of Reliability and Life-Testing Models: Theory, Marcel Dekker, New York,1991.
3. Cow,L.H.,Estimation Procedures for the Duane model,Proc.U.S Army Mater:Syst.Anal,Act.(AMSAA) Reliability Growth Symp.,Aberdeen Proving Ground,Maryland,September 1972.

PEAMIB23 QUALITY & ENVIRONMENTAL MANAGEMENT SYSTEM L T P C

4 0 0 4

OBJECTIVE

To provide the student with the underlying principles and techniques of Quality & Environmental Management System with emphasis on their application to technical organizations. To make students understand about of the best practices in Quality and Process Management and to educate them on the scope, steps, and various methods related to assessment of environmental impact due to developmental projects.

UNIT I INTRODUCTION TO QUALITY & PROCESS IMPROVEMENT 12

Introduction - Definition of quality, TQM, Evolution of quality concepts by Shewhart, Deming, Juran, Crosby, Ishikawa, Taguchi, Shingo, Quality Organization – Focus Groups, Quality Circles, Team formation & Functioning. Process Improvement - The seven tools of quality, Control Charts, Process capability, Six Sigma, New Seven QC Tools.

UNIT II QUALITY MANAGEMENT CONCEPTS 12

Quality Management Concepts - 5S, Benchmarking, Hoshin Planning, , FMEA, Lean Management, Poka Yoke for Zero Defects, SHEQ, PPAP, Taguchi Quality Loss Function, Jishu Hozen(JH), Juran's Trilogy, Quality Function Deployment, Design for Six Sigma, TRIZ, CRM,.

UNIT III QUALITY STANDARDS & AWARDS 12

Quality Standards - basic contents and benefits of ISO 9000 series of standards, ISO 14000 , ISO 17025, QS 9000, TS 16949 and OHSAS 18001 standards, Quality Awards – Demings Prize, IIE Award for Excellence, Japan Quality Award, Presidents Award for Quality.

UNIT IV ENVIRONMENTAL MANAGEMENT TOOLS 12

Introduction- Tools for analysis- Corporate environmental benchmarking-; Environmental auditing- Liability group- Liability audits- Management group- Activates group; Environmental Impact Assessment (EIA)- Life Cycle Assessment- Life Cycle Improvement Analysis; Guidelines and Legal Aspects of Environmental Protection; Environmental Impact Statement (EIS)- Sustainable Development (SD); Risk Assessment- Environmental Management Systems (EMS)- environmental Policy- Eco labeling.

UNIT V INDUSTRIAL POLLUTION CONTROL AND CLEANER PRODUCTION 12

Air Pollution - Effects on Environment and Human Health-Control Measures-Equipment used to control air pollution-Green House Effects - Pollution Prevention and Cleaner Production- Over End of Pipe Approach - Pollution and Cleaner Production Awareness Plan- Waste Minimization Technique- Source Reduction Technique- Recycle-Reuse- Raw Material Substitution; Occupational Health and Hazards- Occupational Diseases-Prevention and Control- Health Protection Measures for Workers- Industrial Safety Standards.

Total = 60 periods

REFERENCE BOOKS

QUALITY MANAGEMENT SYSTEM

1. Quality Management System: 1. Dale H. Besterfiled, et al., "Total Quality Management", Pearson Education, Inc. 2003. (Indian reprint 2004). ISBN 81-297-0260-6.
2. James R.Evans & William M.Lidsay, "The Management and Control of Quality", (5th Edition), South-Western (Thomson Learning), 2002 (ISBN 0-324-06680-5).
3. Feigenbaum.A.V. "Total Quality Management", McGraw-Hill, 1991.
4. Narayana V. and Sreenivasan, N.S. "Quality Management – Concepts and Tasks", New Age International 1996.
5. Armstrong, M., "A Handbook of Management Techniques", Kogan Page Ltd., London.
6. Juran, Quality Planning and Analysis, Tata McGraw Hill, New Delhi.
7. David Garvin, Handbook of Quality.
8. James R. Evans, James W. Dean Jr., Total Quality - Management, Organization and Strategy, Thomson South Western, 2003.

ENVIRONMENTAL MANAGEMENT SYSTEM

1. Lawrence, D.P., Environmental Impact Assessment - Practical solutions to recurrent problems, Wiley- Interscience, New Jersey 2003.
2. Canter, L.W., Environmental Impact Assessment, McGraw-Hill, New York. 1996.
3. Rau, J.G and Wooten, D.C., Environmental Impact Analysis Handbook, McGra-Hill, 1980.
4. Paul L.Bishop, "Pollution Fundamentals and Practice", McGra-Hill International, 2000.
5. World Bank Group, "Pollution Prevention and Abatement Handbook- Towards Cleaner Production", World Bank and UNEP, Washington, D.C, 1998
6. Prasad modak, C.Visvanathan and Mandar parasnis(1995) "Cleaner Production Audit", Environmental System Reviews, Asian Institute of Technology, Bangkok.
7. Krishnamoorthy-Environmental Management PHI-2006
8. Diberardinis, L.J., "Handbook of Occupational Safety and Health", John Wiley, New York, 1998.

PEAMIB24 LEAN MANUFACTURING & FRUGAL ENGINEERING L T P C
3 1 0 4

OBJECTIVE

To understand the lean principles, tools and techniques and its application in manufacturing industries and to acquire knowledge about frugal engineering and its application.

UNIT I INTRODUCTION 12

The new Competitive Business Conditions – Why Programmes fail –meaning of Lean – Pre requisites to becoming Lean- Phases of Changes – TPS – Wastes - Managing Changes in a Large Organisation.

UNIT-II PREPARATION AND TECHNIQUES 12

Lean production preparation – System Assessment – Gap Analysis - Process and Value Stream Mapping – Value engineering - Sources of Wastes – Lean production processes – Tools and Techniques – Tailoring of standard tools and techniques, Visual control, TPM, JIT, Cellular manufacturing, Poka Yoke, One-piece flow, Quick change over, Kanban, Kaizen, Re-engineering techniques, Lean simulation and other modern lean manufacturing techniques.

UNIT III IMPLEMENTATION 12

Implementation of Lean Manufacturing – Employee involvement – Involving people in the change process ergonomics and Lean manufacturing – Training - lean flow – Two paths of implementing lean manufacturing – pit falls in implementing lean manufacturing.

UNIT IV AUDITING AND FOLLOW UP 12

Sustaining Improvement and Changes – Auditing – Follow up actions – Lean and Six Sigma, Agile manufacturing. Lean case studies.

UNIT V FRUGAL ENGINEERING 12

Introduction to Frugal Engineering – Importance – Approaches – Frugal Engineering in Indian Industries – Gandhian Engineering – Strategies for Frugality.

TOTAL: 45+15(Tutorial) = 60 periods

TEXT BOOKS

1. Pascal Dennis., 'Lean Production Simplified', Production Press, 2007.
2. Jeffrey Liker and David Meir., 'The Toyota way field book', Mc Graw Hill, 2006.
3. James P. Womack and Daniel T. Jones., 'Lean Thinking: Banish Waste and Create Wealth in Your Corporation', Revised and Updated, Second Edition, Free Press, 2003.

REFERENCES

1. Dennis Mc Carthy, Dr. Nick Rich., 'Lean TPM', Elsevier Ltd., 2004.
2. Vikas Sehgal, Kevil Dehoff and Ganesh Paneer., 'The Importance of Frugal Engineering', Business Today, National Edition, 13/10/2010.
3. Michael L George, 'Lean Six Sigma', Mc. Graw Hill, 2002.