List of open Electives offered by Automobile Engg Board.

5th Semester

1	Subject Code	Title	Teaching Department	Offering Department
2	15AU561	Automobile Engineering	Automobile Engg.	Automobile Engg.
3	15AU562	Alternative Energy Sources for Automobiles	Automobile Engg.	Automobile Engg.
	15AU563	Non Traditional Machining	Automobile Engg.	Automobile Engg.

6th Semester

1	Subject Code	Title	Teaching Department	Offering Department
2	15AU661	Engineering Economics and Cost Estimation	Automobile Engg.	Automobile Engg.
3	15AU662	Hybrid and Electric Vehicle.	Automobile Engg.	Automobile Engg.
	15AU663	Non- destructive Testing	Automobile Engg.	Automobile Engg.

AUTOMOBILE ENGINEERING

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – V

Subject Code	15AU561	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
Credits	03		

Course objectives: The objectives of this course is to

1. Introduce construction and working of internal combustion engine
2. Explain different components of internal combustion engine
3. Explain working of different parts of fuel system
4. Describe construction of different automotive chassis components
5. Principle of emission of pollutants from internal combustion engines and methods of controlling

Module-I	
Engine Components and auxiliary systems Spark Ignition(SI) & Compression Ignition (CI) engines, cylinder – arrangements and their relatives merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve and port timing diagrams, Types of combustion chambers for S. I. Engine and C. I. Engines, Compression ratio, methods of a Swirl generation, choice of materials for different engine components, engine positioning, cooling requirements, methods of cooling, thermostat valves, different lubrication arrangements.	08 Hours
Module-II	
Fuels, Fuel Supply Systems For SI and CI Engines: Conventional fuels, alternative fuels, cetane and octane numbers, Fuel mixture requirements for SI engines, types of carburetors, multi point and single point fuel injection systems,fuel transfer pumps, Fuel filters, fuel injection pumps and injectors.	08 Hours
Module-III	
Ignition Systems: Battery Ignition systems, Magneto Ignition system, Transistor assist contacts. Electronic Ignition, Automatic Ignition advance systems. **Power Trains:** General arrangement of clutch, Principle of friction clutches, Constructional details, Single plate and multi-plate. Gear box: Necessity for gear ratios in transmission, synchromesh gear boxes, planetary gears, over drives, principle of automatic transmission, calculation of gear ratios, Numerical calculations for torque transmission by clutches	08 Hours
Module-IV	
Drive to Wheels: Propeller shaft and universal joints, , differential, rear axle, , steering geometry, camber, king pin inclination, included angle, castor, toe in & toe out, steering gears, power steering, general arrangements of links and stub axle, types of chassis frames.	08 Hours

Module-V	
Suspension, Springs and Brakes: Requirements, leaf spring, coil spring, independent suspension for front wheel and rear wheel. Air suspension system. Types of brakes, mechanical and hydraulic braking systems, brake shoe arrangements, Disk brakes, drum brakes, Antilock –Braking systems, purpose and operation of antilock-braking system. **Automotive Emission Control Systems:** Sources of emission from engines,Automotive emission controls, Controlling crankcase emissions, Controlling evaporative emissions, Exhaust gas recirculation, Catalytic converter, Emission standards- Euro I, II, III and IV norms, Bharat Stage II, III norms	08 Hours

Course outcomes:

After completion of above course, students will be able to

1. Describe construction and working of internal combustion engine
2. Explain different components of internal combustion engine
3. Explain working of different parts of fuel system
4. Describe construction of different automotive chassis components
5. Explain principle of emission of pollutants from internal combustion engines and methods of controlling.

Question paper pattern:

1. The question paper will have ten questions.
2. Each full question consists of 16 marks.
3. There will be 2full questions (with a maximum of four sub questions) from each module.
4. Each full question will have sub questions covering all the topics under a module.
5. The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Automotive mechanics, William H Crouse & Donald L Anglin,10th Edition Tata McGraw Hill Publishing Company Ltd., 2007
2. Automotive Mechanics, S. Srinivasan, 2nd Ed., Tata McGraw Hill2003.

Reference Books:

1. Automotive mechanics: Principles and Practices- Joseph Heitner, D Van Nostrand Company, Inc
2. Fundamentals of Automobile Engineering- K. K. Ramalingam, Scitech Publications (India) Pvt. Ltd.
3. Automobile Engineering-R. B. Gupta, Satya Prakashan, 4th edn.1984.
4. Automobile engineering-Kirpal Singh. Vol I and II 2002.

ALTERNATIVE ENERGY SOURCES FOR AUTOMOBILES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – V

Subject Code	15AU562	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
Credits	03		

Course objectives: The objectives of this course is to

1. Describe need for alternative fuels for Internal combustion engine and alternative drive systems for automobiles
2. Describe principle of solar energy collection, construction of photo voltaic cells
3. Explain various properties, methods of production of Bio gas, methanol, ethanol, SVO, Bio diesel
4. Explain use of hydrogen for internal combustion engine application.
5. Describe use of various gaseous fuels for internal combustion engine application.
6. Understand various aspects of electrical and Hybrid vehicles

Module-I	
Introduction: Types of energy sources, their availability, need of alternative energy sources, Non-conventional energy sources, Classification of alternative fuels and drive trains. Scenario of conventional auto fuels, oil reserves of the world. Fuel quality aspects related to emissions. Technological up gradation required business driving factors for alternative fuels. Implementation barriers for alternative fuels. Stakeholders of alternative fuels, roadmap for alternative fuels. **Solar energy:** Solar energy geometry, solar radiation measurement devices. Solar energy collectors, types of collectors. Direct application of solar energy, solar energy storage system. P. V. effect solar cells and characteristics. Application of solar energy for automobiles.	08 Hours
Module-II	
Biogas: History, properties and production of Biogas, classification of biogas plants, biogas storage and dispensing system. Advantages of biogas, hazards and emissions of biogas. Production, properties, Engine performance, advantages and disadvantages of Methanol, Ethanol, Butanol, Straight vegetable oil, Biodiesel for internal combustion engine application.	08 Hours
Module-III	
Hydrogen: Properties and production of hydrogen, Storage, Advantages and disadvantages of hydrogen, use of Hydrogen in SI and CI engines. Hazards and safety systems for hydrogen, hydrogen combustion. Emission from hydrogen. **Gaseous fuels:**	08 Hours

Production, properties, Engine performance, advantages and disadvantages of CNG, LNG, ANG, LPG and LFG.	
Module-IV	
Reformulated conventional fuels: Introduction. Production of coal water slurry, properties, as an engine fuel, emissions of CWS. RFG, Emulsified fuels. Hydrogen-enriched gasoline. **Future Alternative Fuels:** Production, properties, Engine performance, advantages and disadvantages of PMF, Ammonia, Liquid-Nitrogen, Boron, Compressed Air, Water as fuel for Internal combustion Engine.	08 Hours
Module-V	
Alternative power trains: Components of an EV, EV batteries, chargers, drives, transmission and power devices. Advantages and disadvantages of EVs. Hybrid electric vehicles, HEV drive train components, advantages of HV. History of dual fuel technology, Applications of DFT. Duel fuel engine operation. Advantages and disadvantages of duel fuel technology.	08 Hours

Course outcomes:

After completion of above course, students will be able to

1. Describe need for alternative fuels for Internal combustion engine and alternative drive systems for automobiles
2. Describe principle of solar energy collection, construction of photo voltaic cells
3. Dxplain various properties, methods of production of Bio gas, methanol, ethanol, SVO, Bio diesel
4. Dxplain use of hydrogen for internal combustion engine application.
5. Describe use of various gasous fuels for internal combustion engine application.
6. Explain various aspects of electrical and Hybrid vehicles

Question paper pattern:

1. The question paper will have ten questions.
2. Each full question consists of 16 marks.
3. There will be 2 full questions (with a maximum of four sub questions) from each module.
4. Each full question will have sub questions covering all the topics under a module.
5. The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Alternative Fuels- S .S. Thipse. JAICO Publishing House.
2. Non-Conventional Energy Sources- G. D. Rai Khanna Publishing New Delhi

Reference Books:

1. Alternative fuels for Vehicle - M. Poulton
2. Alternative fuels guide - R. Bechtold.SAE
3. Alternative energy sources -T.N Veziroglu, McGraw Hill
4. A Primer on Hybrid Electric vehicles
5. Automotive Fuels Guide - Richard L. Bechtold, SAE Publications, 1997

NON TRADITIONAL MACHINING

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – V

Subject Code	15AU563	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
Credits	03		

Course objectives: The objectives of this course is to

1. Discuss the difference between conventional and non conventional machining process.
2. Characterize the USM and AJM with the effect of parameters and process characteristics
3. Explain the working principle ECM and CHM with the effect of parameters and process characteristics.
4. Discuss about the working principle of EDM with the effect of parameters and process characteristics
5. Describe the working principle PAM and LBM with the effect of parameters and process characteristics.

Module-I	
Introduction: Need for non-traditional machining, History, Classification, comparison between conventional and Non-conventional machining process selection. **Ultra sonic machining (USM):** Introduction, equipment, cutting tool system design:- Effect of parameter: Effect various parameters on USM process characteristics: Material removal rate, tool wear, Accuracy, surface finish, applications, advantages & Disadvantages of USM.	08 Hours
Module-II	
Abrasive Jet Machining (AJM): Introduction, Equipment, Variables in AJM: Carrier Gas, Type of abrasive, size of abrasive grain, velocity of the abrasive jet, mean No. abrasive particles per unit volume of the carrier gas, work material, standoff distance (SOD), nozzle design, shape of cut. Process characteristics-Material removal rate, Nozzle wear, Accuracy & surface finish. Applications, advantages & Disadvantages of AJM. **Water Jet Machining :** Principle, Equipment, Operation, Application, Advantages and limitations of water Jet machinery **Electron Beam Machining (EBM):** Principles, equipment, operations, applications, advantages and limitation of EBM.	08 Hours
Module-III	
Electrochemical Machining (ECM) Introduction , study of ECM machine, elements of ECM process classification of ECM process : Cathode tool, Anode work piece, source of DC power, Electrolyte, chemistry of the process, ECM Process characteristics – Material removal rat e, Accuracy, surface finish, ECM Tooling: ECM tooling technique	08 Hours

& example, Tool & insulation materials, Tool size Electrolyte flow arrangement, Handling of slug, Economics of ECM, Applications such as Electrochemical turning, Electrochemical Grinding, Electrochemical Honing, deburring, Advantages, Limitations **Chemical Machining (CHM) :** Introduction, elements of process, chemical blanking process : Preparation of work piece, preparation of masters, masking with photo resists, etching for blanking, accuracy of chemical blanking, applications of chemical blanking, chemical milling (contour machining): process steps –masking, Etching, process characteristics of CHM: ;material removal rate accuracy, surface finish, Hydrogen embrittlement	
Module-IV	
Electrical Discharge Machining (EDM): Introduction, machine, mechanism of metal removal, dielectric fluid, spark generator, EDM tools (electrodes) Electrode feed control, Electrode manufacture, Electrode wear , EDM tool design choice of machining operation electrode material selection, under sizing and length of electrode , machining time. Flushing pressure flushing suction flushing, side flushing, pulsed flushing synchronized with electrode movement, EDM process characteristics: metal removal rate, accuracy surface finish, Heat affected Zone. Machine tool selection, Application EDM accessories / applications, electrical discharge grinding, Traveling wire EDM.	08 Hours
Module-V	
Plasma Arc Machining (PAM): Introduction, equipment non-thermal generation of plasma, selection of gas, Mechanism of metal removal, PAM parameters, process characteristics. Safety precautions, Applications, Advantages and limitations. **Laser Beam Machining (LBM):** Introduction, equipment of LBM mechanism of metal removal, LBM parameters, Process characteristics, Applications, Advantages & limitations.	08 Hours

Course outcomes:

After completion of above course, the student will be able to

1. Discuss the difference between conventional and non conventional machining process.
2. Characterize the USM and AJM with the effect of parameters and process characteristics.
3. Explain the working principle ECM and CHM with the effect of parameters and process characteristics.
4. Discuss about the working principle of EDM with the effect of parameters and process characteristics
5. Describe the working principle PAM and LBM with the effect of parameters and process characteristics.

Question paper pattern:

1. The question paper will have ten questions.
2. Each full question consists of 16 marks.
3. There will be 2full questions (with a maximum of four sub questions) from each module.

4. Each full question will have sub questions covering all the topics under a module.
5. The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Modern Machining Process- Pandey and Shah, Tata McGraw Hill 2000
2. New technology - Bhattacharaya 2000

Reference Books:

1. Production Technology- HMT TATA McGraw Hill. 2001
2. Modern Machining Process -ADITYA. 2002
3. Non-Conventional Machining - P. K. Mishra, The Institution of Engineers (India) Test book series, Narosa Publishing House – 2005.
4. Metals Handbook: Machining(Hardcover) - Joseph R. Davis (Editor), American Society of Metals (ASM) volume 16

ENGINEERING ECONOMICS AND COST ESTIMATION

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

Subject Code	15AU661	IA Marks	20

Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
Credits	03		

Course objectives: The objectives of this course is to

1. Explain method to Perform and evaluate present worth, future worth and annual worth analyses on one of more economic alternatives.
2. Explain evaluation of payback period and capitalized cost on one or more economic alternatives.
3. Describe method to Carry out and evaluate benefit/cost, life cycle and breakeven analyses on one or more economic alternatives
4. Discuss Preparation of cost estimation report for any project.
5. Describe to evaluate cost accounting, replacement analysis.

Module-I	
Introduction Definition of various economic terms such as economic goods, utility, value, price, wealth, wants capital, rent and profit, Laws of returns **Demand and supply & wages** Law of diminishing utility and total utility. Demand Schedule, Law of demand. Elasticity of demand, Law of substitution, Law of supply, supply schedule, elasticity of supply. Nominal and real wages, Factors affecting real wages, theory of wages, Difference in wages, methods of wage payment	08 Hours
Module-II	
Money and exchange Theory of exchange, Barter, stock exchange, Speculation money qualities of a good money, function of a money, classification of money, value of money, index number, appreciation and depreciation of money value, Gresham's Law and its limitations **Taxation and insurance** Principle of taxation, characteristics of a good taxation system, kinds of taxes, and their merits and demerits, Vehicle Insurance, Loss Assessment.	08 Hours
Module-III	
Interest and depreciation Introduction, theory of interest, interest rate, interest from lender's and borrower's view point, simple and compound interest. Nominal and effective interest rates, interest formulae annual compounding, annual payments and continuous compounding annual payment, simplenumerical problems. Need for depreciation, causes of depreciation life and salvage value methods of depreciation, simple numerical problems.	08 Hours
Module-IV	
Costs: Standard costs estimated cost, First cost, Fixed cost, Variable costs, Incremental cost, Differential cost, Sunk and marginal cost, Breakeven and minimum cost analysis, simple numerical problems. **Cost Accounting:** Introduction, objectives of cost accounting, elements of cost material cost, labour cost, and expenses, allocation of overheads by different methods,	08 Hours

simple numerical problems.	
Module-V	
Book Keeping and accounts: Introduction, Necessity of book keeping, single entry and double entry system, Classification of assets, Journal, Ledger, Trial balance, Final accounts, trading, profit and loss account, Balance sheet, Numerical **Cost Estimation:** Introduction, importance, objectives and functions of estimating, principle factors in estimating, Functions and qualities of an estimator, estimating procedure. Estimation of material cost and manufacturing cost of simple automotive components, Estimation of cost of overhauling and servicing of automotive components - cylinder, valves, valve seats, crankshaft, FIP, Brake drum, body building, different types of repairs.	08 Hours

Course outcomes:

After completion of above course, the student will be able to

1. Perform and evaluate present worth, future worth and annual worth analyses on one of more economic alternatives.
2. evaluate payback period and capitalized cost on one or more economic alternatives.
3. Carry out and evaluate benefit/cost, life cycle and breakeven analyses on one or more economic alternatives
4. Prepare a cost estimate for any project.
5. Perform and evaluate cost accounting, replacement analysis

Question paper pattern:

1. The question paper will have Ten questions.
2. Each full question consists of 16 marks.
3. There will be 2 full questions (with a maximum of four sub questions) from each module.
4. Each full question will have sub questions covering all the topics under a module.
5. The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Engineering Economics, Tara Chand, Nem Chand and Brothers, Roorkee
2. Engineering Economy, Thuesen, G. J. and Fabrycky, W. J., Prentice Hall of India Pvt. Ltd.
3. Mechanical Estimating and Costing, T. R. Banga and S. C. Sharma, Khanna Publishers, Delhi

Reference Books:

1. Industrial Organization and Engineering Economics- T. R. Banga and S. C. Sharma, Khanna Publishers, New Delhi
2. Mechanical Estimating and Costing- D. Kannappan et al., Tata McGraw Hill Publishing CompanyLtd., New Delhi
3. A Text Book of Mechanical Estimating and Costing-O.P. Khanna, Dhanpat Rai Publications Pvt.Ltd., New Delhi
4. Industrial Engineering and Management- O. P. Khanna, DhanpatRai and Sons, New Delhi
5. Financial Management-I. M. Pandey, Vikas Publishing House Pvt. Ltd., New Delhi

6. Engineering Economics- James L. Riggs, David D. Bedworth and Sabah U. Randhawa, Tata McGraw-Hill Publishing Co. Ltd., New Delhi

HYBRID AND ELECTRIC VEHICLE. [As per Choice Based Credit System (CBCS) scheme] SEMESTER – VI			
Subject Code	15AU662	IA Marks	20

Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
Credits	03		

Course objectives: The objectives of this course is to

1. Explain how a hybrid vehicle works and describe its main components and their function.
2. Analyze the performance of a hybrid vehicle.
3. Evaluate the environmental impact of road vehicles.
4. Describe the operating principle and properties for the most common types of electrical motors in hybrid technology.

Module-I	
Introduction: Performance characteristics of road vehicles, calculation of road load, predicting fuel economy, Grid connected hybrids **DC motors:** Series wound, shunt wound. Compound wound and separately excited	08 Hours
Module-II	
AC motors: Induction, synchronous, brushless DC motor, switched reluctance motors. **Hybrid architecture**: Series configuration- locomotive drives, series parallel switching, load tracking architecture. Pre transmission parallel and combined configurations-Mild hybrid, power assist, dual mode, power split, power split with shift, Continuously Variable transmission (CVT). Wheel motor	08 Hours
Module-III	
Hybrid power plant specifications Grade and cruise targets. Launching and boosting, braking and energy recuperation drive cycle implications, engine fraction-engine downsizing and range and performance, usage requirements.	08 Hours
Module-IV	
Sizing the drive system Matching electric drive and ICE, sizing the propulsion motor, sizing power electronics **Energy storage technology:** Battery basics, different types of batteries (lead-acid battery / Lithium / Alkaline), High discharge capacitors, flywheels, battery parameters	08 Hours
Module-V	
Fuel cells Fuel cell characteristics, fuel cell types - alkaline fuel cell, proton exchange membrane, direct methanol fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, hydrogen storage systems, reformers, fuel cell EV	08 Hours

Course outcomes:

After completion of above course, the student will be able to

1. Explain how a hybrid vehicle works and describe its main components and their function.
2. Analyze the performance of a hybrid vehicle.
3. Evaluate the environmental impact of road vehicles.

4. Describe the operating principle and properties for the most common types of electrical motors in hybrid technology

Question paper pattern:

The question paper will have ten questions.

1. Each full question consists of 16 marks.
2. There will be 2full questions (with a maximum of four sub questions) from each module.
3. Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. The Electric Car: Development & Future of Battery, Hybrid &Fuel-Cell Cars - Dr Mike Westbrook, M H Westbrook, British library Cataloguing in Publication Data, UK, ISBN0 85296 0131.
2. Electric and Hybrid Vehicles - Robin Hardy, Iqbal Husain, CRC Press, ISBN 0-8493-1466-6.
3. Propulsion Systems for Hybrid Vehicles - John M. Miller, Institute of Electrical Engineers, London, ISBN0 863413366.

Reference Books:

1. Energy Technology Analysis Prospects for Hydrogen and Fuel Cells, International Energy Agency, France.
2. Hand Book of Electric Motors - Hamid A Taliyat, Gerald B Kliman, Mercel Dekker Inc., US, ISBN0-8247-4105-6

NON- DESTRUCTIVE TESTING

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

Subject Code	15AU663	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80

Total Number of Lecture Hours	40	Exam Hours	03
Credits	03		

Course objectives: The objectives of this course is to

1. Explain Principles of selection of non destructive Evaluation method (NDE)
2. Describe various inspection methods like Magnetic particle, Radiographic Inspection their Principle, general procedure, advantages and limitations
3. Explain Verification of proper assembly and Inspect for in-service damage.

Module-I	
Selection of NDE methods Flaw detection & evaluation, leak detection & evaluation, metrology & evaluation, structure / microstructure characterization, visual inspection. **Replication microscopy techniques for NDE** Specimen preparation, replication techniques, and micro structural analysis. **Liquid penetrant Inspection**: Principles penetrate methods, procedure, materials used, equipment, parameters, and applications.	08 Hours
Module-II	
Magnetic particle inspection: Principle, general procedure, advantages & limitation, applications, magnetic field generation, magnetic hysteresis, magnetic particles & suspending liquid **Radiographic inspection**: Principles, X-ray radiography, equipment, Gamma - Ray radiography, real time radiography & film radiography, application examples.	08 Hours
Module-III	
Computed tomography (CT) Principles, capabilities, comparison to other NDE methods, CT equipment, industrial computed tomography applications. **Thermal Inspection**: Principles, equipment, inspection methods applications.	08 Hours
Module-IV	
Optical Holography: Basics of Holography, recording and reconstruction-info metric techniques of inspection, procedures of inspection, typical applications. Acoustical Holography: systems and techniques applications. **Eddy current inspection**: Principles of operation, procedure, advantages & limitations, operating variables, inspection coils, eddy current instruments, application examples.	08 Hours
Module-V	
Ultrasonic inspection: Principles basic equipment, advantages & limitations, applicability, major variables in ultrasonic inspection, basic inspection methods- pulse echo method, transducers and couplants. **Acoustic emission inspection:**	08 Hours

Principles comparison with other NDE methods, applicability, Acoustic emission waves & propagation, instrumentation principles.	

Course outcomes:

After completion of above course, the student will be able to

1. Explain Principles of selection of NDE
2. Describe various inspection methods like Magnetic particle, Radiographic Inspection their Principle, general procedure, advantages and limitations
3. Monitor, improve or control manufacturing processes.
4. Verify proper assembly and Inspect for in-service damage

Question paper pattern:

1. The question paper will have ten questions.
2. Each full question consists of 16 marks.
3. There will be 2full questions (with a maximum of four sub questions) from each module.
4. Each full question will have sub questions covering all the topics under a module.
5. The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Metals hand book, Vol-17,9th Edition, Nondestructive evaluation & quality control, American society of metals.
2. Handbooks of American Society for Nondestructive testing.

Reference Books:

1. Non Destructive testing - Mc Gonnagle JJ – Garden and reach New York
2. Non destructive Evolution and quality control volume 17 of metals hand book 9 edition Asia internal 1989
3. the Testing instruction of Engineering materials- Davis H.E Troxel G.E Wiskovil C.T Mc Graw Hill.