



C. U. SHAH UNIVERSITY

Wadhwan City

FACULTY OF: - Technology and Engineering
DEPARTMENT OF: - Automobile Engineering
SEMESTER: -III
CODE: - 4TE03EMT1
NAME: – Engineering Mathematics – 3 (EMT)

Teaching and Evaluation Scheme:-

Subject Code	Name of the Subject	Teaching Scheme (Hours)				Credits	Evaluation Scheme							
		Th	Tu	Pr	Total		Theory				Practical (Marks)			Total
							Sessional Exam		University Exam		Internal		University	
							Marks	Hrs	Marks	Hrs	Pr/Viva	TW	Pr	
4TE03EMT1	Engineering Mathematics - 3	4	0	0	4	4	30	1.5	70	3	---	---	---	100

Objectives:

- To represent periodic functions in terms of infinite trigonometric series
- To solve higher order ordinary differential equations
- To solve linear partial differential equations of first and second order
- To learn Laplace transform technique
- To study the numerical methods to solve transcendental equations

Prerequisite:

Students should have a firm grasp elementary engineering mathematics offered in first and second semesters. The basic concepts of calculus and algebra must be clear.

Course Outline:

Sr. No.	Course Content	Hours
1	Fourier Series : Periodic functions, Dirichlet's conditions, Trigonometric series, Euler's formulae, Fourier expansion of periodic functions with period 2π , Fourier series of even and odd functions, Fourier series of periodic functions with arbitrary periods, half range Fourier series, Harmonic analysis.	10
2	Laplace Transforms and Applications: Definition of the Laplace transform, Inverse Laplace transform, Linearity property, First Shifting theorem, Laplace Transforms of derivatives and integrals, Differentiation and integration of Laplace transforms, Convolution theorem, Solution of Differential equations using Laplace Transform, Unit step function, Second shifting theorem, Dirac's delta function.	15

3	Ordinary Differential Equations and Applications: Linear differential equations of second and higher order: Higher order linear differential equations with constant coefficients, Complementary Function (C.F.), Short cut methods for finding Particular Integrals (P.I.), General method: $[1/f(D)] r(x)$ method for finding particular integral, Wronskian, Solution by method of variation of parameters, Cauchy's Homogeneous linear differential equation, Legendre's Homogeneous linear differential equation, Modeling of Electric circuits.	15
4	Partial Differential Equations and Applications: Formation of PDEs, Solution of Partial Differential equations $f(x,y,z,p,q) = 0$, Solution of PDE by direct integration, Linear PDEs with constant coefficients, Classification of second order linear PDEs, Applications of PDE: Separation of variables, Solution of Wave equation, Heat equation and Laplace equation.	15
5	Numerical solution of Algebraic & Transcendental equation Solution of algebraic and transcendental equations: Bisection method, Regula falsi method, Secant method, Newton-Raphson method, rate of convergence	05

Learning Outcomes:

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

- express physical phenomenon in mathematical form
- represent periodic function as a series in terms of sine and cosine
- Solve differential equations by using tools like Laplace transform and Fourier series.
- To solve second order partial differential equations: wave equation, heat equation, laplace equation.

Teaching & Learning Methodology:

- Lecture method using standard teaching aids.
- Solving term assignments in tutorials.
- Quiz/Seminar/Expert lectures

Books Recommended:

1. Advanced Engineering Mathematics (8th Edition), E. Kreyszig, Wiley-India (2007).
2. Higher Engineering Mathematics – Vol. 2, Dr. K. R. Kachot, Mahajan Publ. house
3. Engineering Mathematics -Vol 2, by Baburam, Pearson.
4. Higher Engineering Mathematics, Thirty-fifth edition. B. S. Grewal, Khanna Publication.
5. Elementary Differential Equations (8th Edition), W. E. Boyce and R. DiPrima, John Wiley (2005).
6. Fourier series and boundary value problems, R. V. Churchill and J. W. Brown, McGraw-Hill (7th Edition - 2006).
7. Numerical Methods, by B. S. Grewal, Khanna Publ.

E-Resources:

- 1 <http://www.wiley.com/college/mat/kreyszig154962/>
- 2 <http://en.wikipedia.org/wiki/Portal:Mathematics>
- 3 <http://www.online.math.uh.edu>



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FACULTY OF: - Technology and Engineering
DEPARTMENT OF: - Automobile Engineering
SEMESTER: - III
CODE: - 4TE03EMN1
NAME: – Electrical Machines & Electronics (EMN)

Teaching and Evaluation Scheme:-

Subject Code	Name of the Subject	Teaching Scheme (Hours)				Credits	Evaluation Scheme							
		Th	Tu	Pr	Total		Theory				Practical (Marks)			Total
							Sessional Exam		University Exam		Internal		University	
							Marks	Hrs	Marks	Hrs	Pr/Viva	TW	Pr	
4TE03EMN1	Electrical Machines& Electronics	3	0	2	5	4	30	1.5	70	3	30	20	---	150

Objectives:

- To expose the students to the concepts of various types of electrical machines and applications of electrical machines.

Prerequisites:

- Students should have knowledge of basic electrical engineering and fundamentals of physics.
- They should know the derivatives and integration.

Course Outline:

Sr. No.	Course Content	Hours
1	D.C. Generator: Generator Principle, Simple loop generator, Practical generator, Yoke-pole Cores and Poles Shoes-Pole Coils-Armature Winding-Brushes and Bearing, types of generators, E.M.F. equation, open circuit characteristic, external characteristic and internal characteristic of DC generator, Uses of DC Generators.	05
2	D.C. Motors: Construction, Types, Principle of operation, torque equation, losses and efficiency, speed torque characteristics of shunt, series and compound motor, D.C. shunt motor starter, speed control of D.C. shunt and series motors.	05
3	Single Phase Transformer: Working Principle of single-phase transformer, Transformer Construction, Core type and Shell type transformer, E.M.F. equation, operation at no load and on load, vector diagram, equivalent circuit, losses, efficiency and regulation, parallel operation, auto transformer, condition for maximum efficiency, all day efficiency.	06

4	Three Phase Induction Motor : Classification of a.c. motor, General Principle, Construction, Squirrel cage-Phase wound rotor, Production of rotating field, Relation between torque and rotor power factor, Synchronous Speed, speed of rotor field, slip, Various methods of measurement of slip, starting & running torque, torque-slip characteristics, losses and efficiency, starters for 3 phase induction motor, speed control.	06
5.	Alternator: Introduction, construction, details, exciters, alternator operation on load, voltage regulation, losses & efficiency, parallel operation of alternators, synchronizing procedure of alternators, cooling of alternators.	06
6.	Supply systems: Electric supply system, typical A.C. power supply system, comparison of D.C. and A.C. transmission, advantages of high transmission voltage, various systems of power transmission, comparison of conductor material in overhead system, economic choice of transmission voltage.	06
7.	Tariffs and Power factor improvement: Types of tariffs, energy bill calculations, disadvantages of low power factor, causes of low power factor, power factor improvement, calculation of power factor correction, importance of power factor improvement, most economical power factor.	06
8.	Substation: Classification of substations, comparison of indoor and outdoor sub stations, Transformer substation, pole mounted substations, underground substations.	03
9.	Diode, Transistor and OPAMP Circuits: Half wave rectifier circuits, Full wave rectifier, Full wave bridge rectifier, Three phase bridge rectifier, Common Emitter amplifier, Multistage amplifier, Symbol and pin diagram of IC 741 OPAMP, OPAMP circuits- inverting, non-inverting, differential, comparator.	06
10.	Logic Gates and Boolean Algebra: Basic logic circuits: Logic gates (AND, OR, NOT, NAND, Ex-OR, Ex-NOR and their truth tables), Laws of Boolean algebra, De-Morgan's theorem.	03

Learning Outcomes:

To impart knowledge on

- Constructional details, principle of operation, Performance, starters and speed control of DC Machines
- Constructional details, principle of operation of Transformer.
- Constructional details, principle of operation of Induction Motor.
- Different types of tariffs and supply systems.
- Basics of diodes transistor and OPAMP circuits.

Books Recommended:

1. Electrical Technology Vol II, by B. L. Theraja, S. Chand Publications
2. Performance and Design of A.C. machines, by M. G. Say, CBS Publication
3. Electrical Machines, by P. S. Bhimbhra, Khanna Publication
4. Electrical Machines, by J. B. Gupta, Kataria Publications
5. Electrical Machines, by Samarjit Singh – Pearson Education
6. Electrical Machines, By Nagarath & Kothari, TMH Publications
7. Principles of Power system, by V.K. Mehta, S. Chand publication, 4th edition
8. Fundamentals of Digital circuits, by A. Anand Kumar, PHI Learning Ltd.



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FACULTY OF: - Technology and Engineering
DEPARTMENT OF: - Automobile Engineering
SEMESTER: - III
CODE: - 4TE03KDM1
NAME: – Kinematics & Dynamics of Machines (KDM)

Teaching and Evaluation Scheme:-

Subject Code	Name of the Subject	Teaching Scheme (Hours)				Credits	Evaluation Scheme							
		Th	Tu	Pr	Total		Theory				Practical (Marks)			Total
							Sessional Exam		University Exam		Internal		University	
							Marks	Hrs	Marks	Hrs	Pr/Viva	TW	Pr	
4TE03KDM1	Kinematics & Dynamics of Machines	3	0	2	5	4	30	1.5	70	3	30	20	---	150

Objectives:

- To understand various parts involved in kinematics & Dynamics of machines for different applications.
- To gain basic knowledge of Gear design, Cam and Follower design, balancing and vibration.

Prerequisites:

- Basic knowledge of Mathematics and physics.

Course Outline:

Sr. No.	Course Content	Hours
1.	Simple mechanism: Link, Kinematic chains and their classification, mechanism and machine, Inversions - four-bar chain and single slider crank chain, various types of quick return motions. Pantograph, straight line motion mechanisms.	06
2.	Motion analysis: Angular and linear velocities in link mechanism, velocity and acceleration diagram for slider - crank chain and four-bar chain mechanism including coriolis component of acceleration. Analytical methods of Kinematic analysis.	07
3.	Flexible power transmission system, geometrical Configuration: Analysis of forces and power transmission. Effects of centrifugal force, creep and initial tension.	04
4.	Gears: Classification of gears, types of motion, law of gear tooth action, involute and cycloidal tooth profile - interference of gears - minimum number of teeth to avoid interference, contact ratio. Helical, spiral, worm and bevel gears, Introduction to gear train and types of trains.	06
5.	Cams: Types of cams and followers. Drawing a cam profiles for a given displacement - time diagram, analysis of cam profiles with specified contours.	06
6.	Gyroscope: Angular Velocity, Angular acceleration, Gyroscopic Torque, gyroscopic effect on naval ships, stability of automobile, stability of two wheel and four wheel automobile	05

7.	Vibrations in mechanical systems: Introduction, Basic features of vibration systems - single degree of freedom systems and vibration isolation.	06
8.	Balancing: Forces due to revolving masses. Balancing of revolving masses in one plane and in different planes.	05

Learning Outcomes:

Learner should be able to

- Understand the basic concepts of various mechanisms & its Inversions.
- Draw velocity and acceleration diagrams of various mechanisms.
- Design CAM and Follower as per the application requirement.
- Understand the basics which are applies in Gear design.
- Understand the vibration and balancing concept which are affect to the production and with the help of this knowledge they can develop the balanced design which is free from vibration.

Books Recommended:

1. Theory of Machines by S.S.Rattan., Tata Mc Graw Hill.
2. Theory of Machines by Jagdish Lal., Metropolitan Book Co.
3. Theory of Mechanisms and Machines by Amitabha Ghosh & Mallik, A. K. East West Press.
4. Mechanism & Machine Theory by Rao J. S. and Duggipati R. V., New Age International Pub.
5. Kinematics and Dynamics of Machinery by Charles E. Wilson & J.Peter Sadler Pearson Education publications.



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FACULTY OF: - Technology & Engineering
DEPARTMENT OF: - Automobile Engineering
SEMESTER: - III
CODE: - 4TE03AME1
NAME: – Automotive Measurement (AME)

Teaching and Evaluation Scheme:-

Subject Code	Name of the Subject	Teaching Scheme (Hours)				Credits	Evaluation Scheme							
		Th	Tu	Pr	Total		Theory				Practical (Marks)			Total
							Sessional Exam		University Exam		Internal		University	
							Marks	Hrs	Marks	Hrs	Pr/Viva	TW	Pr	
4TE03AME1	Automotive Measurement	3	0	2	5	4	30	1.5	70	3	30	20	---	150

Objectives:

- To understand the basic principle of measurement various.
- To Prepare Students for designing tools, inspection and testing.

Prerequisites:

- Basic knowledge of Physics

Course outline:

Sr. No.	Course Content	Hours
PART – A (Mechanical Measurements)		
1	Introduction to Measurements: Generalized measurement system, static & dynamic characteristics of instruments, types of measurement system, Instrumental error & its analysis, sensors and transducers.	06
2	Temperature Measurement: Expansion Thermometers, Change- of state thermometers parametric cones, electrical methods, pyrometry, radiation pyrometers, optical pyrometer, Calibration of temperature measuring instruments.	08
3	Pressure Measurement: Pressure standards and methods of pressure measurement , deadweight pressure gauge, manometers, elastic deformation gauges, electrical methods, piezoelectric pressure transducer, measurement of vacuum pressures, calibration , etc.	08
4	Measurement of Vibration and Sound: Importance of vibration measurement, classification of vibration measuring instruments, accelerometer, importance of acoustical measurement, sound pressure and power levels, types of microphones - capacitive, crystal, electrostatics, carbon, sound level meter. Harshness measurement. Other Measurements: Thermal conductivity gauge, Pitot gauge, Ionization	06

	gauge, Crank position, Cam position	
PART – B (Metrology)		
5	Fundamentals of metrology: Meaning, objectives, necessity, standards of measurement, method of measurement, precision and accuracy, sources of errors, standardizing organizations.	05
7	Linear Measurements: Engineer's steel rule, Callipers, Verniers, Micrometers, Slip gauges, Dial indicators etc, and their applications, advantages and limitations.	06
8	Angular Measurement: Working principle, construction, measurement procedure, error and elimination, limitations and calibration of different angular measuring instruments. Taper measurement.	06

Learning Outcomes:

- Students will be able to perform the similar type of instrument in their future when exposed to the industrial environments.

Books Recommended:

- Engineering Metrology, by R. K. Jain, Khanna Publishers.
- Mechanical Measurement, by R. K. Jain, Khanna Publishers.
- Mechanical Measurement and Control, by D. S. Kumar, Metropolitan Book Co. Pvt. Ltd., New Delhi.
- Mechanical Measurement and Instrumentation, by R. K. Rajput, Katson Book.

References:

- Mechanical Measurement and Control, by D. S. Kumar, Metropolitan Book Co. Pvt. Ltd., New Delhi.
- Measurement Systems, by E. O. Doebelin, McGraw Hill.
- Mechanical Measurements T. G. Beckwith, by R. D. Marangoni & J. H. Lienhard V, Pearson (LPE).
- Experimental Methods for Engineers, by J. P. Holman, McGraw Hill.
- Engineering Measurement, by Collets and Hope ELBS.



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Wadhwan City

FACULTY OF:-Technology and Engineering
DEPARTMENT OF:-Automobile Engineering
SEMESTER:- III
CODE:- 4TE03MDI1
NAME – Machine Design & Industrial Drafting (MDI)

Teaching and Evaluation Scheme:-

Subject Code	Name of the Subject	Teaching Scheme (Hours)				Credits	Evaluation Scheme							
		Th	Tu	Pr	Total		Theory				Practical (Marks)			Total
							Sessional Exam		University Exam		Internal		University	
							Marks	Hrs	Marks	Hrs	Pr/Viva	TW	Pr	
4TE03MDI1	Machine Design & Industrial Drafting	4	0	2	6	5	30	1.5	70	3	30	20	---	150

Objectives:

- To design and development of machinery utilizing advances in the field of material & manufacturing technology.
- To learn systematic approach to Basic Fundamentals and Component Design of the simple machine elements.
- To teach students mechanical engineering design theory to identify and quantify machine elements in the design of commonly used mechanical systems.
- To develop analytical abilities for providing solutions to engineering design problems.
- To recognize those factors constituting a practical, functional, efficient, and safe mechanical design.

Prerequisites:

- Basic Knowledge of Strength of materials,
- Basic Knowledge of Engineering Drawing
- Analytical knowledge.
- Derivatives and integration.

Course outline:

PART A (Machine Design)

Sr. No.	Course Content	Hours
1	Introduction: Design engineering, Design consideration of Machine Parts: Definition and understanding of various types of design, basic requirements and procedure of design, design synthesis, selection of preferred sizes, Selection of materials, Properties and I.S. factors of safety, stress concentration and methods of relieving stresses	05
2	Design Against Static Load: Modes of failure, factor of safety, types of loads and stresses, design of simple parts subjected to tension, compression, shear, bending, torsion and combined loads	05

3	Design of Operational Joints: Introduction, Strength of joints, Cotter Joints, Sleeve type cotter joint, Cotter for foundation bolt, Tapered rod connection with cotter, Gib & Cotter Joint, Knuckle Joint, Threaded Fasteners, Design load for Fasteners, Turnbuckle, Bolt of Uniform strength.	07
4	a) Design of Riveted Joints: Types of riveted joints, advantages and limitations of riveted joints, types of riveted joints, design of riveted joints, efficiency of riveted joints b) Welded Joints : Types of welded joints, stresses in welded joints, design for various loading conditions in torsion, shear, or direct load, eccentrically loaded welded Joints, welding symbols	07
5	Design of Shafts: Introduction, standard sizes, design consideration, material used for shafts, design of solid shaft based on strength and rigidity, A.S.M.E. code for shaft design, shafts subjected to fluctuating loads, hollow shafts.	08
6	Keys and Coupling: Types of keys, design of different types of keys, design of a muff and clamp coupling, rigid coupling, flange coupling, flexible coupling- Oldham, universal coupling.	05
7	Power Screws: Introduction, Types of power screw threads, design of screw with different types of threads used in practice, design of nuts, design of C clamp, screw jack, toggle jack.	06
8	Levers: General Procedure for design of levers, Weight reduction of levers, Hand levers & Foot Levers, design of lever for safety valve, design of bell crank lever, design of rocker arm for exhaust valves.	05

PART: B (Industrial Drafting)

1	Assembly Drawings: Drawings of assembled view for the part drawings of the following using propionate dimensions. a) Engine parts – cylinder, liners, piston, connecting rod, crank shaft, stuffing boxes, cross heads, Eccentrics. b) Machine parts - Screws jacks, Machine Vices, Plummer block, Tailstock. c) Valves: Steam stop valve, spring loaded safety valve, feed check valve and air cock	03
2	Production Drawing: Elements of production drawing, Fits and tolerance, allocation of fits for various mating parts, Geometric tolerance, Hole basis system and shaft basis system.	02
3	Surface Roughness: Roughness and Machining symbols, indication on drawings.	02

PART C (Auto CAD)

1	Applications of CAD: Starting with AutoCAD, AutoCAD dialog boxes, Co-ordinate Systems, drawing lines, circle, arcs, rectangle, ellipse, polygons, etc. Editing Sketched Objects: Editing sketches, moving, copying, pasting, offsetting, scaling, chamfering, trimming, mirroring. Filletting, sketched objects.	02
2	Basic Dimensioning: Geometric dimensioning and Tolerance: Dimensioning AutoCAD, Creating linear, rotated, angular aligned base line Dimensions, Modifying dimensions.	02

3	Creating and modifying 3D objects using AutoCAD. Plotting the drawings in AutoCAD, plotting drawing using the plot dialog box, adding plotters and using plot styles, plotting sheets.	01
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Learning Outcomes:

- Students will develop the ability to make proper assumptions & design specific mechanical components like shaft, keys, coupling, screw jack etc.
- Student can gain knowledge of assembly drawing of engine parts, machine parts etc. &
- The students appreciate that Auto CAD provide a valuable resource tool for the futuristic design.
- This course will give the student some insight, to the working behind readily available Auto CAD software.
- Able to use design data books and different codes of design.

Books Recommended:

1. Machine Design, by P.C Sharma and D. K. Aggarwal, S. K. Kataria & Sons 2009
2. Design of Machine Elements , by V. B. Bhandari, Tata McGraw Hill Publishing Co.
3. Machine Drawing, by N.D. Bhatt, Charator Publication
4. Machine Design – An Integrated Approach, by Robert L Norton, Pearson Education.
5. Machine Drawing by P.S. Gill, S.K. Kataria & Sons New Delhi
6. Auto CAD 2009 , by Sham Tickoo, Cengage learning Indian Edition
7. Mechanical Engineering Design, by Joseph Edward Shigley and Charles R. Mischke, McGraw Hill International Edition,
8. PSG Design Data Book
9. Machine Design: vol-1, by R. C. Patel and A. D. Pandya, C. Jamnadas & Co.
10. Machine Design - Solved Problems, by S. G. Kulkarni, Tata McGraw Hill Publishing Company Ltd., New Delhi
11. Machine elements: life and design, by Boris M. Klebanov, David M. Barlam, Frederic E. Nystrom
12. Machine Design: vol-1, by R. C. Patel and A. D. Pandya, C. Jamnadas & Co.
13. Machine Drawing, by S. Chand Publication P.J Shah

References:

1. ASME Journal of Mechanical Design (<http://asmedl.aip.org/MechanicalDesign>)
2. IEEE (<http://ieeexplore.ieee.org>)
3. E book- <http://scribd.com>
4. www.kettering.edu/academics/...use/machine-design
5. www.sciencedirect.com



C. U. SHAH UNIVERSITY
Wadhwan City

FACULTY OF:-Technology & Engineering
DEPARTMENT OF:- Automobile Engineering
SEMESTER:- III
CODE:- 4TE03MTE1
NAME – Material Technology (MTE)

Teaching and Evaluation Scheme:-

Subject Code	Name of the Subject	Teaching Scheme (Hours)				Credits	Evaluation Scheme							
		Th	Tu	Pr	Total		Theory				Practical (Marks)			Total
							Sessional Exam		University Exam		Internal		University	
							Marks	Hrs	Marks	Hrs	Pr/Viva	TW	Pr	
4TE03MTE1	Material Technology	3	0	2	5	4	30	1.5	70	3	30	20	---	150

Objectives:

- To impart the basic knowledge about material in general as a prime element in design and manufacturing environment.
- It also clears the importance of engineering materials selection in various fields of mechanical applications.
- The availability of wide range of materials makes it essential to select most suitable material for the suitable application with most specific

Prerequisites:

- Basic knowledge of Physics.

Course outline:

Sr. No.	Course content	Hours
1.	Introduction of Materials and Crystallography: Introduction to materials, basic properties, selection of engineering materials, crystal structure of metals, space lattice, No. of atoms per unit cell and atomic packing factors, Miller indices, growth of metal crystals.	06
2.	Theory of Alloys and Phase Diagrams: Solid solutions], Significance of alloying, equilibrium diagrams for binary alloy systems and their limitations, allotropy forms of Iron, Influence of Carbon as alloying element, Iron-Carbon equilibrium diagram, and significance of IC diagram in heat treatments.	07
3.	Defects in Crystals: Types of defects, dislocation theories, geometry of dislocations, motion of dislocations, multiplication of dislocations, Frank-reed source of dislocation, dislocation Pile-up.	06
4.	Ferrous and Non Ferrous Metals and Alloys: Types, properties, structure and applications of steels and Cast Irons, Steel specifications as per IS, AISI/SAE, BS, Types, properties, structure and applications of Copper, Aluminum, Magnesium and Nickel alloys.	06
5.	Heat Treatment of Steels: Time Temperature Transformation diagram (TTT),	07

	classification of heat treatment process, softening treatment: Annealing, normalizing, tempering etc, Hardening treatment, surface hardening treatments, heat treatment of Copper and Aluminum alloys, hardenability tests.	
6.	Testing of Materials: Non-destructive testing, visual inspection, hammer test, radiography, X-ray radiography, Magnetic particle inspection, Liquid penetrant test, Ultrasonic inspection	07
7.	Powder Metallurgy: Definition and concept, history, primary and secondary processes, metal powder production, applications, drawbacks and advantages.	06

Learning Outcomes:

- Students will be confident to select the material in their fields of interest.
- The subject helps the students to prove capability for testing and characterization of materials.
- The practical performance develops the team work spirit and accuracy in work of an individual student.

Books Recommended:

1. A Text book of Material Science and Metallurgy, by O. P. Khanna, Dhanpat Rai Publications.
2. Engineering Material Technology, by W. Bolton, Butterworth Hrinemann Publications.
3. Material Science and Engineering: An Introduction, by W. D. Calister, John Wiley & Sons, Inc.
4. Introduction to Physical Metallurgy, by S. H. Avner, Tata McGraw Hill Publications.
5. Physical Metallurgy, by Vijendra Singh, Standard Publishers Distributors.

References:

1. Elements of Material Science and Engineering, L. H. Vanblack, Pearson Education India.
2. Mechanical Metallurgy, by George E. Dieter, McGraw Hill Publications, NY.
3. ASTM Hand Book, Volume 1,2,3,4,8,10,17
4. Experiments in Material Technology, By C. A. Higgeson, pub/affiliated East- West Press