Department of Robotics and Mechatronics Engineering
University of Dhaka

Semester Rule for B.Sc. in Robotics and Mechatronics Engineering
Session: 2017-18 and 2018-19

1. **Duration of the Program:** 4 years.
2. **Total Semester:** 8 (2 semester per year).
3. **Total Credits:** 160
4. **Class**: 15 active weeks (1 day of each week must be reserved for makeup classes. If necessary, weekends can be used for makeup classes and extra/additional classes may be taken within the semester schedule to finish the course).
5. **Preparatory Leave:** 2 weeks (No separate break for in-course examinations)
6. **Teaching of the courses:**

   a. For each credit of a theory course, there will be 1 class per week of 1 hour duration.

   b. Total classes in a semester for each credit of a theory course will be 15 (15x1).

   c. Total Contact Hours in a semester for each 1 credit theory course: 15x1=15.

   d. For each 1 credit lab course, there will be 1 class per week of 2 hours duration.

   e. Total classes in a semester for each 1 credit lab course in 15 weeks: 15x1=15.

   f. Total Contact Hours in a semester for each 1 credit lab course: 15x2=30.

7. **Evaluation of the courses:**

   The answer scripts will be evaluated by two examiners. The average mark will be considered as the achieved mark. The script will be evaluated by a third examiner if the difference of marks received from these two examiners is more than 20%. In case of third examination, average of nearest two marks will be considered as the achieved mark.

8. **Grading System:** The current UGC approved grading system applies as per university rules.

Marks	Letter Grade	Grade Point
80% and Above	A+	4.00
75% to < 80%	A	3.75
70% to < 75%	A-	3.50
65% to < 70%	B+	3.25
60% to < 65%	B	3.00
55% to < 60%	B-	2.75
50% to < 55%	C+	2.50
45% to < 50%	C	2.25
40% to < 45%	D	2.00
Less Than 40%	F	0.00

9. **Marks Distribution:**

Theory Course:

i.	Attendance	5%
ii.	Assignment / Presentation	5%
iii.	In-course	30%
iv.	Final Examination	60%
	Total Marks	100%

Lab Course:

i.	Attendance	5%
ii.	Continuous Evaluation	40%
iii.	Viva	15%
iv.	Final Examination	40%
	Total Marks	100%

10. **Promotion and the Final Degree:**

a. The minimum CGPA (Cumulative Grade Point Average) 2.00, 2.25, 2.5 will be required for promotion from 2nd, 4th, 6th semester to the next respectively (year to year promotion).

b. The minimum GP of 2.00 is required in each theory and lab courses, and minimum CGPA of 2.5 will be required for award of the B. Sc. Degree.

c. The Degree must be earned within the limit of 12 semesters, i.e. 6 academic years from the date of admission to the 1st semester.

d. There will be no option for grace.

11. **Re-admission and Drop Out:**

a. A student failing to get promotion may seek re-admission to study with the following batch. In the case of re-admission, all previously earned grades for the two semesters of that year will be cancelled.

b. A student may take re-admission only 2 times. If required, a student may take re-admission in the same class, but the Degree must be completed within 6 years.

c. A student failing to get minimum required CGPA even after taking re-admission twice will be dropped out of the program.

12. **Improvement of Grades:**

a. A student will be allowed maximum of 2 chances to clear F grade/grades with the immediate next batches by complying with the time requirement for the degree

including final year (4^{th} year). A student will not be allowed for grade improvement once s/he is eligible for the degree.

b. A student getting F grade in any theory course (courses) has to attend only the final examination for that (those) course (courses).

c. A student may improve grade/grades of any course only once by reappearing at the examination with the immediate next batch if he/she obtains a grade less than or equal to C+ (GP=2.50) and the best grade that a student can achieve in case of grade improve is B+.

d. In addition to the usual fees, a fine, as per university rules, will be imposed for each course chosen for improvement.

e. A student will have to be mentally prepared to take the examination of a particular course chosen for improvement even if it is held on the same day of his/her other regular examination.

Department of Robotics and Mechatronics Engineering
University of Dhaka

Syllabus for B.Sc. in Robotics and Mechatronics Engineering
Session : 2017-18 and 2018-2019

Semester-I (First Year First Semester)		
Course Code	**Course Title**	**Credit Hour**
Theory Courses		
RME 1101	Fundamentals of Mechanical Engineering	3
RME 1102	Fundamentals of Computing	3
RME 1103	Differential and Integral Calculus	3
RME 1104	Physics	3
RME 1105	Chemistry	3
Lab Courses		
RME 1114	Physics Lab	1.5
RME 1115	Chemistry Lab	1.5
RME 1116	Engineering Drawing Lab	1.5
RME 1117	Machine Shop and Workshop Practices Lab	1.5
	Total Credits:	**21**

Semester-II (First Year Second Semester)		
Course Code	**Course Title**	**Credit Hour**
Theory Courses		
RME 1201	Fundamentals of Mechatronics Engineering	3
RME 1202	Fundamentals of Electrical and Electronics Engineering	3
RME 1203	Fundamentals of Programming	3
RME 1204	Linear Algebra	3
RME 1205	Accounting	3
RME 1206	Functional English	2
Lab Courses		
RME 1211	Fundamentals of Mechatronics Engineering Lab	1.5
RME 1212	Fundamentals of Electrical and Electronics Engineering Lab	1.5
RME 1213	Fundamentals of Programming Lab	1.5
	Total Credits:	**21.5**

Semester-III (Second Year First Semester)		
Course Code	**Course Title**	**Credit Hour**
Theory Courses		
RME 2101	Instrumentation and Measurement	3
RME 2102	Digital Logic Circuit and Microprocessor	3
RME 2103	Engineering Mechanics	3
RME 2104	Multivariate and Vector Calculus	3
RME 2105	Managerial and Engineering Economics	3
RME 2106	Society and Technology	3
Lab Courses		
RME 2111	Instrumentation and measurement Lab	1.5
RME 2112	Digital Logic Circuit and Microprocessor Lab	1.5
	Total Credits:	**21**

Semester-IV (Second Year Second Semester)		
Course Code	**Course Title**	**Credit Hour**
Theory Courses		
RME 2201	Introduction to Robotics	3
RME 2202	Microcontroller and Programmable Logic Controller	3
RME 2203	Object Oriented Programming	3
RME 2204	Electrical Machines	3
RME 2205	Differential Equations and Coordinate Geometry	3
RME 2206	Statistics for Engineers	3
Lab Courses		
RME 2211	Introduction to Robotics Lab	1.5
RME 2212	Microcontroller and Programmable Logic Controller Lab	1.5
RME 2213	Object Oriented Programming Lab	1.5
	Total Credits:	22.5

Semester-V (Third Year First Semester)		
Course Code	**Course Title**	**Credit Hour**
Theory Courses		
RME 3101	Artificial Intelligence	3
RME 3102	Advanced Mechatronics Engineering	3
RME 3103	Mechanics of Solids and Fluids	3
RME 3104	Mathematical Analysis for Engineers	3
RME 3105	Industrial Management	3
Lab Courses		
RME 3111	Artificial Intelligence Lab	1.5
RME 3112	Advanced Mechatronics Engineering Lab	1.5
RME 3113	Mechanics of Solids and Fluids Lab	1.5
	Total Credits:	**19.5**

Semester-VI (Third Year Second Semester)		
Course Code	**Course Title**	**Credit Hour**
Theory Courses		
RME 3201	Intelligent Systems and Robotics	3
RME 3202	Manufacturing Process with CNC Programming	3
RME 3203	Power Electronics and Drives	3
RME 3204	Control Systems Design	3
RME 3205	Bangladesh Studies	2
Lab Courses		
RME 3211	Intelligent Systems and Robotics Lab	1.5
RME 3212	Manufacturing Process with CNC Programming Lab	1.5
RME 3213	Power Electronics and Drives Lab	1.5
	Total Credits:	**18.5**

Semester-VII (Fourth Year First Semester)		
Course Code	**Course Title**	**Credit Hour**
Theory Courses		
RME 4101	Advanced Robotics	3
RME 4102	Digital Image Processing and Robot Vision	3
RME 4103	Digital Signal Processing	3
RME 4104	Mechanical Power Transmission Systems	3
Lab Courses		
RME 4111	Advanced Robotics Lab	1.5
RME 4112	Digital Image Processing and Robot Vision Lab	1.5
RME 4113	Digital Signal Processing Lab	
RME 4115	Research Methodology, Technical and Scientific Writing Lab	1.5
Project Work		
RME 4100	Project	2
	Total Credits:	**20**

Semester-VIII (Fourth Year Second Semester)		
Course Code	**Course Title**	**Credit Hour**
Theory Courses		
RME 4201	Human Robot Interaction	3
RME 422x	Optional Course I (From Group A)	3
RME 422x	Optional Course II (From Group B)	3
Lab Courses		
RME 4211	Human Robot Interaction Lab	1.5
RME 423x	Optional Course I Lab (From Group A)	1.5
Project Work		
RME 4200	Project	4
	Total Credits:	**16**

List of Optional Courses		
Course Code	**Course Title**	**Credit Hour**
Group - A		
RME 4221	Introduction to Machine Learning	3
RME 4222	Introduction to Biomedical Engineering	3
RME 4223	Mobile Robotics	3
RME 4224	Simulation and Modeling	3
RME 4231	Introduction to Machine Learning Lab	1.5
RME 4232	Introduction to Biomedical Engineering Lab	1.5
RME 4233	Mobile Robotics Lab	1.5
RME 4234	Simulation and Modeling Lab	1.5
Group - B		
RME 4225	Material Science and Engineering	3
RME 4226	Machine Design and System Dynamics	3
RME 4227	Introduction to Nanoscience and Nanotechnology	3
RME 4228	Introduction to Automobile Engineering	3

Summary of Eight Semesters

Semester I (First Year First Semester)	21
Semester II (First Year Second Semester)	21.5
Semester III (Second Year First Semester)	21
Semester IV (Second Year Second Semester)	22.5
Semester V (Third Year First Semester)	19.5
Semester VI (Third Year Second Semester)	18.5
Semester VII (Fourth Year First Semester)	20
Semester VIII (Fourth Year Second Semester)	16
Total Credit in Eight Semesters	**160**

Semester-I (First Year First Semester)

RME 1101: Fundamentals of Mechanical Engineering - 3 Credit

Introduction: Scope of Mechanical Engineering, Study of Sources of Energy- Conventional and Renewable Energy.

Thermodynamics: Fundamental Concepts and Laws, Thermodynamic Properties, Open and Closed Systems, Control Volumes, Thermodynamic Cycles, Reversibility and Irreversibility, Equation of State.

Heat Transfer: Introduction to Heat Transfer, Modes of Heat Transfer, Steady and Unsteady State Heat Conduction, Convection Heat transfer - Natural and Forced Convection, Radiation Heat Transfer.

Major Mechanical Applications: Introduction to Internal Combustion Engines and Their Cycles, Automobiles, Steam Generation Units with Accessories and Mountings, Fluid Machinery- Fan, Blower, Compressor and Pump (Classification and Working Principles), Study of Impulse and Reaction Turbines, Refrigeration and Air-conditioning Systems.

Books Recommended:

1. Engineering Thermodynamics – Michael J. Moran, Howard N. Shapiro, Daisie D. Boettner and Margaret B. Bailey, Wiley.
2. Introduction to Thermodynamics and Heat Transfer - Yunus A. Cengel, McGraw Hill.
3. Heat Engineering - V.P. Vasandani and D.S.Kumar, Metropolitan.

RME 1102: Fundamentals of Computing – 3 Credit

Number System: Binary, Decimal, Hexadecimal, Octal number systems, Arithmetic in Different Number Systems.

Combinatorial Logic: Logic Gates and Boolean Algebra, Combinational Circuits Design using Logic Gates, Minimization of Functions, Algebraic Simplification, The Karnaugh Map.

Introduction to Computers: Components of a Computer System, Importance and Limitations of Computers, Classification of Computers, Computer Generations.

Input and Output Devices: I/O Operations and Interfaces, Input Devices, Output Devices.

Microprocessors: Functions of Microprocessors, Organization of a Microprocessor, Arithmetic Logic Unit, Control Unit.

Memory Organization: Classification of Memory, Memory Hierarchies, Primary Memory, Secondary Memory, Comparisons of Primary Memory and Secondary Memory.

Computer Software: Software, Classification of Software, Programming Languages, The Role of BIOS, Language Translators, Operating System, Tasks of an OS, Types of OS.

Computer Networks and the Internet: Introduction to Computer Network, Network Terminologies, LAN Topology, Transmission Media, Communication Over Telephone Lines, Evolution of the Internet, Internet Services, Internet Address, Electronic Mail, The World Wide Web.

IT Applications: Concepts and Applications of IT, Electronic Commerce, Access, Control, Security.

Books Recommended:

1. Digital Systems: Principles and Applications - Ronald Tocci, Neal Widmer and Greg Moss, Prentice Hall.
2. Computer Fundamentals - Pradeep K. Sinha and Priti Sinha, BPB Publications.
3. Introduction to Computers - Peter Norton, McGraw-Hill Education.

RME 1103: Differential and Integral Calculus - 3 Credit

Differential Calculus:

Functions: Functions and their Graphs (Polynomial, Rational, Logarithmic, Exponential, Trigonometric, Hyperbolic Functions and Combination of such Functions

Limits, Continuity and Differentiability: Concepts and Definitions, One Sided Limits, Limit at Infinity and Infinite Limits, Limit Laws, Sandwich Theorem, Continuous and Discontinuous Functions with Properties, Intermediate Value Theorem, One Sided Derivatives, Differentiability of Functions.

Differentiation: Tangent Lines and Rates of Change, Techniques of Differentiation, Chain Rule, Derivatives of Various Functions, Successive Differentiation, Leibnitz Theorem, Related Rates, Indeterminate Forms, L'Hospital's Rule.

Applications of Differentiations: Analysis of Functions, Absolute Extrema, Applied Maximum and Minimum Problems, Rolle's Theorem, Mean-Value Theorem.

Integral Calculus:

Integration: Indefinite Integral (Integration by Substitution, Integration by Parts, Standard Integrations, Integration by Successive Reduction), Definite Integrals, Fundamental Theorem of Calculus, Properties of Definite Integrals.

Applications of Integration: Area between Two Curves, Volume of Solid by Slicing, Disk and Washers, Volume by Cylindrical Shells, Arc Length, Area of a Surface of Revolution. Improper Integrals: Different Types of Improper Integrals.

Books Recommended:

1. Calculus: Early Transcendentals - H. Anton and I. Bivens and S. Davis, Wiley.
2. Calculus and Analytic Geometry - G. B. Thomas and R. L. Finney, Addison Wesley.

3. Calculus: Early Transcendentals - J. Stewart, Thomson Brooks/Cole.
4. Calculus - R.T. Smith and R. B. Minton, McGraw-Hill Education

RME 1104: Physics - 3 Credit

Mechanics: Basic Concepts of Mechanics, Statics of Particles and Rigid Bodies, Newton's Second Law of Motion, Principles of Work, Energy, System of Particles, Kinetics of Plane Motion of Rigid Bodies, Forces and Acceleration, Principles of Work and Energy, Law of Gravitation.

Waves and Oscillations: Differential Equation of a Simple Harmonic Oscillator, Total Energy and Average Energy, Combination of Simple Harmonic Oscillations, Damped Oscillation, Determination of Damping Co-Efficient, Forced Oscillation, Resonance, Two-Body Oscillations, Reduced Mass, Laplace's Correction, Doppler Effect, Newton's Law of Velocity.

Relativity: Michelson Morley's Experiment, Galilean Transformation, Special Theory of Relativity, Lorentz- Transformation, Length Contraction, Time Dilation, Mass-Energy Relation.

Radioactivity: Radioactive Decay, Half Life, Mean Life, Nuclear Binding Energy, Alpha, Beta, Gamma Decay, Photoelectric Effect.

Books Recommended:

1. Physics (Volume I and II) - Robert Resnick, David Halliday and Kenneth S. Krane, Wiley
2. Fundamentals of Physics - David Halliday, Robert Resnick and Jearl Walker, Wiley
3. Concepts of Modern Physics - Arthur Beiser and Shobhit Mahajan, McGraw Hill Education

RME 1105: Chemistry - 3 Credit

Modern Concepts of Atomic Structure, Modern Periodic Table with Reference to Group Chemistry, Quantum Number, Dual Nature of Electron, Heisenberg Principle, Pauli Exclusion Principle, Electronic Configuration and Modem Concepts of Chemical Bonds, Properties and Molecular Structure, Oxidation Reduction Reaction, Modern Concepts of Acids and Bases, Different Types of Organic Reactions, Different Types of Solutions and their Compositions, Properties of Solutions, Phase Rule, Phase Diagram of Monocomponent Systems, Thermochemistry, Chemical Kinetics, Chemical Equilibrium, Electrical Properties of Solution and Electrochemical Cells, Spectrohotometry, Colorimeter.

Books Recommended:

1. Introductory Chemistry – John P. Sevenair and Allan R. Burkett, William C Brown Pub.
2. General Chemistry – Darrell Ebbing and Steven D. Gammon, Brooks Cole.
3. Physical Chemistry – Peter Atkins and Julio de Paula, OUP Oxford.
4. Introduction to Modern Organic Chemistry – S.Z. Haider, Friends International.

RME 1114: Physics Lab – 1.5 Credit

Practical Classes based on the Topics Covered in **RME 1104.**

RME 1115: Chemistry Lab – 1.5 Credit

Practical Classes based on the Topics Covered in **RME 1105.**

RME 1116: Engineering Drawing Lab – 1.5 Credit

Introduction to Mechanical Drawing, Introduction to Lettering, Numbering and Heading, Instrument and their Uses, First and Third Angle Projections, Orthographic Drawings, Missing Lines and Views, Sectional Views and Conventional Practices, Auxiliary Views, Pictorial Drawing- Isometric Views, Surface Development, Introduction to Computer Aided Drawing.

Books Recommended:

1. Engineering Drawing – M. B. Shah and B. C. Rana, Pearson Education.
2. Machine Drawing – N. D. Junnarkar, Pearson Education.
3. Machine Drawing with Auto CAD - Goutam Pohit, Pearson Education.
4. Mechanical Engineering Drawing – Amalesh Chandra Mandal and Md. Quamrul Islam, DAERS (BUET).

RME 1117: Machine Shop and Workshop Practices Lab – 1.5 Credit

Foundry: Introduction to Foundry, Tools and Equipment.

Patterns: Function, Pattern Making.

Molding: Molding Materials, Types of Mold, Procedure.

Cores: Types, Core Making Materials, Metal Melting and Casting.

Tools: Hand Tools, Power Tools, Safety Rules for Workshop Practices.

Practices on Machine Tools: Lathe Machine, Drilling Machine, Shaper Machine, Milling Machine, Grinding Machine.

Metal Joints: Riveting, Grooving, Soldering.

Welding Practice: Electric Arch Welding, Spot Welding, Pressure Welding.

Semester-II (First Year Second Semester)

RME 1201: Fundamentals of Mechatronics Engineering - 3 Credit

Introduction: Definition and Components of Mechatronics, Applications of Mechatronics, Relationship amongst Different Disciplines.

System Models: Building Blocks of Electrical, Mechanical, Fluid and Thermal Systems, Electromechanical Systems.

Control Systems: Open and Closed Loop Systems, Analogue and Digital Control Systems.

Sensors and Transducers: Sensors for Displacement, Proximity, Motion, Sound, Light, Temperature, Force, Pressure, Fluid Level, Fluid Flow etc.

Signal Conditioning and Data Acquisition: Filtering, Pulse Modulation, A/D and D/A Converters, Multiplexers, Data Acquisition Systems.

Actuation Systems: Basics of Pneumatic and Hydraulic Actuation Systems, Mechanical Actuation Systems, Electrical Actuation Systems.

Controllers: Control Modes, PID and Digital Controllers, Velocity Control, Adaptive Control, Microprocessor and Microcontrollers, Programmable Logic Controllers: Fundamentals of PLCs, Mnemonics and Timers, Relays and Counters, Master and Jump Control, Data Control, Analog I/O Control.

Design of Mechatronics Systems: Steps of Mechatronics System Design, Possible Design Solutions.

Case Studies on Application of Mechatronics Systems.

Books Recommended:

1. Introduction to Mechatronics and Measurement Systems - Michael B., Histand and David G. Alciatore, McGraw-Hill.
2. Mechatronics: Electronic Control Systems in Mechanical and Electrical Enginneering - W. Bolton, Prentice Hall.
3. Mechatronics Engineering - Sastry, Tata McGraw Hill.

RME 1202: Fundamentals of Electrical and Electronics Engineering - 3 Credit

Electrical:

Direct Current Circuits: Laws and Theorems.

DC Network Analysis: Delta/Star Transformation, Source Conversion.

Circuit Variables and Elements: Voltage, Current, Power, Energy, Independent and Dependent Sources, and Resistance.

Basic Laws: Ohm's Law, Kirchoff's Current and Voltage Laws. Simple Resistive Circuits: Series and Parallel Circuits, Voltage and Current Division.

Techniques of Circuit Analysis: Nodal and Mesh Analysis including Supernode and Supermesh with Applications in Circuits having Independent and Dependent Sources.

Network Theorems: Source Transformation, Thevenin's, Norton's and Superposition Theorems with Applications in Circuits having Independent and Dependent Sources, Maximum Power Transfer Condition and Reciprocity Theorem.

Alternating Current: AC Quantities and Sinusoidal Waveforms, Phasors, AC Circuit Analysis: Series and Parallel Branches-RL, RC, and RLC. Balanced Three Phase Circuits.

Energy Storage Elements: Inductors and Capacitors, Series Parallel Combination of Inductors and Capacitors.

Electronics:

Semiconductor Diode: Basics of Semiconductor, Semiconductor Operation, Characteristics and Applications, Diode Rectifiers (Half-Wave Rectifier and Full-Wave Rectifier).

Bipolar Junction Transistors (BJTs): Introduction to Bipolar Junction Transistors, Characteristics of BJTs, Common–Emitter (CE), Common-Base (CB) and Common-Collector (CC) Amplifier Configurations, Voltage and Current Gain, Input and Output Impedance of a Common Base, Common Emitter and Common Collector Amplifier Circuits.

Metal Oxide Semiconductor Field Effect Transistor (MOSFET): Structure and Physical Operation of an Enhancement MOSFET, Biasing Discrete and Integrated MOS Amplifier Circuits, Single-stage MOS Amplifiers, MOSFET as a Switch, CMOS Inverter.

Junction Field Effect Transistor (JFET): Structure and Physical Operation of JFET, JFET Characteristics.

Operational Amplifiers (Op-Amp): Properties of Ideal Op-Amps, Non-inverting and Inverting Amplifiers, Inverting Integrators, Differentiator.

Books Recommended:

1. Introduction to Circuit Analysis- Robert L. Boylestad, Pearson.
2. A Text Book of Electrical Technology- B.L. Theraja and A.K. Theraja, S Chand & Company Ltd.
3. Fundamentals of Electric Circuits – Charles K. Alexander and Matthew N.O. Sadiku, McGraw Hill Education.
4. Principle of Electronics -V. K. Mehta**,** S Chand & Company Ltd.
5. Grob's Basic Electronics - Mitchel E. Schultz, McGraw-Hill.
6. Fundamentals of Electrical Engineering - Robert P. Ward, Prentice-Hall.
7. Electronic Circuits: Discrete and Integrated - Donald L. Schilling, Mcgraw-Hill.

RME 1203: Fundamentals of Programming – 3 Credit

Basic Concepts: Introduction to Computer Programming, Problem Solving Techniques, Algorithm Specification and Development. Programming Style, Debugging and Testing, Documentation.

Data Types and Conditional Logics: Basic I/O, Data Types, Conditional Logics such as If, If-Else, Switch.

Operators: Arithmetic, Relational, Logical and Bitwise Operators, Operator Precedence and Associativity, Arithmetic Expression Evaluation.

Loops: Looping Basic, Necessity of Loops, While Loop, For Loop, Do While Loop, Nested Loop.

Formatted I/O: Specifying Width using Format Specifier in printf and scanf in Details.

Arrays: Basics of Array, Accessing through Indices, Accessing using Loops, Two Dimensional Arrays.

Functions: Basic Functions, Different Types of Functions, Local and Global Variables, Call by Value, Call by Reference, Passing Arrays in a Function as Parameter, Recursion, Scope Visibility and Lifetime of Variable.

Strings: Basics, I/O Operations using String, Basic Operations without using Library Functions, Basic String Operations.

Structures: Basics, Accessing, Initialization, Array of Structures.

Pointers: Basics, Pointer Operation, Call by Reference using Pointers, Pointer for Array, Array of Pointers.

Dynamic Memory Allocation: Basics, Malloc, Free, Calloc.

File Operation: Basics, File Opening, Closing, File I/O.

Books Recommended:

1. The C Programming Language - Brian W. Kernighan and Dennis M. Ritchie, Prentice Hall.
2. Programming in ANSI C - E. Balagurusamy, Tata McGraw-Hill Education.
3. C the Complete Reference - Herbert Schieldt, McGraw-Hill Education.

RME 1204: Linear Algebra - 3 Credit

Matrices and Determinants: Notion of Matrix, Types of Matrices, Matrix Operations, Laws of Matrix Algebra, Determinants and Properties of Determinants, Minors, Cofactors, Expansion and Evaluation of Determinants, Elementary Row and Column Operations and Row-reduced Echelon Matrices.

System of Linear Equations: Linear Equations, System of Linear Equations (Homogeneous and Non-homogeneous), Solutions of System of Linear Equations using Different Methods, Applications to Network Flow and Electrical Networks.

Vector Space: Vectors in $\mathbb{R}^n$ and $\mathbb{C}^n$, Vector Space, Subspace, Linear Dependence of Vectors, Basis and Dimension of Vector Spaces, Change of Bases, Row Space and Column Space of Matrix, Rank of Matrices, Solution Space of System of Linear Equations.

Linear Transformation: Linear Transformations, Example and Illustrations with Applications, Kernel and Image of a Linear Transformation and their Properties.

Eigenvalues and Eigenvectors of Matrices: Eigenvalues and Eigenvectors, Diagonalization, Cayley-Hamilton Theorem, Applications.

Books Recommended:

1. Elementary Linear Algebra: Applications Version - H. Anton & C. Rorres, John-Wiley & Sons.
2. Linear Algebra - S. Lipshutz, Schaum's Outline Series.
3. Linear Algebra and Its Applications - David C. Lay, Addison Wesley.

RME 1205: Accounting – 3 Credit

Financial Accounting: Accounting-Objectives, Importance, Three Activities, Users, Building Blocks of Accounting- Ethics, Standards, Principles, Assumptions, Accounting as an Information System, Computerized System and Applications in Accounting, Double Entry Mechanism, Accounts and their Classifications, Accounting Equation, Accounting Cycle, Steps in the Recording Process, Journal, Ledger, Trial Balance, Worksheet, Preparation of Financial Statements Considering Adjusting and Closing Entries, Accounting for Merchandising Operations, Financial Statement Analysis and Interpretation.

Cost and Management Accounting: Evolution of Cost and Management Accounting, Financial Accounting vs. Management Accounting, Cost Accounting vs. Management Accounting, the Management Accountant: the Controller Function, Cost Concepts and Classification, Material, Labor, Overhead, Cost Behavior Analysis, Preparation of Cost Sheets, Job Order Costing, Absorption Costing and Variable Costing Technique, Cost-Volume-Profit Analysis, Budgeting and Budgetary Control, Standard Costing, Short-Term Investment Decisions - Relevant and Differential Cost Analysis, Long-Term Investment Decisions - Capital Budgeting, Various Techniques of Evaluation of Capital Investments.

Books Recommended:

1. Financial Accounting – Jerry J. Weygandt, Paul D. Kimmel and Donald E. Kieso, IFRS Edition John Wiley & Sons, Inc.
2. Managerial Accounting - R. H. Garrison and E. W. Noreen, McGraw-Hill Irwin.
3. Cost Accounting: Planning & Control - Milton F. Usry and Lawrence H. Hammer, South-Western Publishing Co.
4. Introduction to Management Accounting - C. T. Horngren, G. Sundem and W. O. Stratton, Prentice Hall.
5. Advanced Accounting - M.M. Khan.

RME 1206: Functional English – 2 Credit

Grammar: Articles, Verb Patterns, Sentence Combining Subordination and Coordination, Conditional Sentences, The Infinitive, Gerund, and Participle, Subject-Verb Agreement.

Writing: Paragraph and Analytical Writings, Writing on Current Affairs, Scientific Writing. Commercial Correspondences: Defining Context, Feedback and Semantic Gap. Different types of Commercial and Business Letter Writing, Writing of Different Types of Reports on Specific Topics. Reading: Basic Reading Skills (Skimming, Scanning, Making Inferences, Recognizing Patterns) and Apply these Skills in an Extensive Reading Environment.

Speaking: Developing Speaking Skill which will include Strategies for Communication and an Acquaintance with Phonetics. Effective Oral Presentation. Tasks will include Making Statements, Requests, Inquiries, Disagreeing, Complaining and Apologizing, Discussing, and other Oral Presentations.

Listening: Practice Listening to Spoken English and Taking Useful Notes.

Books Recommended:

1. A Practical English Grammar - A.J. Thomson and A.V. Martinet, Oxford University Press.
2. From Paragraph to Essay: Developing Composition Writing - Maurice L Imhoof and Herman Hudson, Longman.
3. Advancing Language Skills - Clive Taylor, University Grants Commission.
4. Advanced Writing Skills - John Arnold and Jeremy Harmer, Longman.
5. Effective Reading - Simon Greenall and Michael Swan, Cambridge.
6. Writing Voyage: A Process Approach to Basic Writing - Thomas E. Tyner, Harcourt College Publisher.
7. View Points: Interviews for Listening - Robert O'Neill and Reger Scott.
8. Business Correspondence and Report Writing– R. Sharma and Krishna Mohan, McGraw Hill Education.

RME 1211: Fundamentals of Mechatronics Engineering Lab – 1.5 Credit

Practical Classes based on the Topics Covered in **RME 1201**.

RME 1212: Fundamentals of Electrical and Electronics Engineering Lab - 1.5 Credit

Practical Classes based on the Topics Covered in **RME 1202.**

RME 1213: Fundamentals of Programming Lab - 1.5 Credit

Practical Classes based on the Topics Covered in **RME 1203.**

Semester-III (Second Year First Semester)

RME 2101: Instrumentation and Measurement - 3 Credit

Introduction: Basic Principles of Measurements, Characterization and Behavior of Typical Measuring Systems, Major Elements of Measuring Systems, Basics of Measurement Techniques of Displacement, Temperature, Heat, Motion, Vibration, Force, Torque, Strain.

Industrial Pressure and Level Measurements: Industrial Pressure Measurement, Definition of Pressure, Types of Pressure Measuring Element, Examples and Applications of Pressure Measuring Elements, Definition of Level, Types of Level Measuring Elements, Examples and Applications of Level Measuring Elements.

Measurement of Power and Energy: Induction and Electrodynamometer, Induction Type Wattmeter, Maximum Demand Indicator, Power Factor Meter.

Error in Measurement and their Statistical Analysis: Types of Error, Statistical Treatment of Measurement Data, Probability of Errors and Gaussian Error Curve, Limiting Errors.

Function and Operation of Digital Data Acquisition System, Case Studies on Temperature Measurement and Flow Measurement.

Books Recommended:

1. Principles of Measurement Systems –J. P. Bentley, Prentice Hall.
2. Intelligent Sensor Systems – J. E. Brignell , N. M. White, John Brignell, CRC Press.
3. A Course in Electronic Measurements and Instrumentation – A.K. Sawhney, Dhanpat Rai & Co. Limited

RME 2102: Digital Logic Circuit and Microprocessor - 3 Credit

Digital Logic Circuit:

Arithmetic Circuits: Half Adder, Full Adder, Half Subtractor, Full Subtractor, Parallel Adder/Subtractor.

Sequential Logic: NAND and NOR Latches, Different Types of Flip-Flops, FF Timing Consideration.

Complex Sequential Logic: Frequency Division and Counting, Different Types of Counters, Propagation Delay, Decoding a Counter, Shift Registers.

MSI Logic Circuits: Decoder and Encoder, Multiplexer and Demultiplexer, Analog-to-Digital Converter, Digital-to-Analog Converter.

Memory Devices: Semiconductor Memory Technologies, ROM Architecture, RAM Architecture.

Microprocessor:

Introduction to Microprocessor: Evolution of Microprocessor, Overview of Microcomputer.

8086 Microprocessor: Introduction, Architecture, Instruction Sets, Constructing Machine Codes for 8086 Instructions, Addressing Modes, Interrupts and 8259A (Priority Interrupt Controller), Higher Versions of 8086.

Pentium Microprocessor: Introduction to Pentium Microprocessor, Pentium Processor Architecture, Register Sets, Cache, Floating Point Operations, Addressing Modes, Paging, Instruction Set, Interrupt, Protected Mode Operations.

Books Recommended:

1. Digital Systems: Principles and Applications - Ronald Tocci, Neal Widmer and Greg Moss Prentice Hall.
2. Logic and Computer Design Fundamentals - M. M. Mano and C. R. Kime, Prentice-Hall.
3. Microprocessors and Interfacing: Programming and Hardware- D.V. Hall, McGraw-Hill
4. The Pentium Microprocessor - James L. Antonakos, Pearson.

RME 2103: Engineering Mechanics - 3 Credit

Introduction to Mechanics: Basic Concepts of Mechanics, Statics of Particles, Equivalent System of Forces in Rigid Bodies, Equilibrium of Rigid Bodies.

Centroid and Center of Gravity: Centroids of Lines, Areas and Volumes. Center of Gravity of 2D and 3D Bodies, Center of Gravity of Composite Bodies.

Analysis of Structures: Analysis of Trusses by Method of Joints and Method of Section, Analysis of Frames and Machines, Forces in Beams and Cables.

Friction: Types of Friction, Laws of Friction, Angles of Friction, Wedges.

Moment of Inertia: Moments of Inertia of Areas, Moment of Inertia of Mass.

Kinematics: Kinematics of Particles, Kinematics of Rigid Bodies.

Kinetics: Kinetics of Particles- Newton's Second Law of Motion, Principles of Work, Energy, Impulse and Momentum, System of Particles. Kinetics of Plane Motion of Rigid Bodies- Forces and Acceleration.

Books Recommended:

1. Vector Mechanics for Engineers: Statics - Ferdinand P. Beer, E. Russell Johnston Jr., Phillip J. Cornwell, McGraw-Hill Education.
2. Vector Mechanics for Engineers: Dynamics - Ferdinand P. Beer, E. Russell Johnston Jr., Phillip J. Cornwell, McGraw-Hill Education.
3. Engineering Mechanics: Statics - Russell C. Hibbeler, Pearson.
4. Engineering Mechanics: Dynamics - Russell C. Hibbeler, Pearson.

RME 2104: Multivariate and Vector Calculus – 3 Credit

Vectors and Geometry of Space: Three Dimensional Coordinate Systems, Dot Product and Cross Product of Vectors, Lines and Planes in 3-space, Cylindrical and Quadric Surfaces. Vector Valued Functions: Calculus of Vector Valued Functions, Arc Length, Unit Tangent, Normal and Binormal Vectors, Curvature, Motion in Space. Partial Derivatives: Functions of Two or More Variables, Limit and Continuity, Partial Derivatives, Chain Rule, Taylor Series, Directional Derivatives, Tangent Planes and Normal Vectors, Maxima and Minima of Functions of Two Variables, Lagrange Multipliers. Multiple Integral: Double Integrals (Over Rectangular and Nonrectangular Regions and in Polar Coordinates), Triple Integrals in Rectangular Coordinates, Cylindrical Coordinates and Spherical Coordinates, Change of Variables in Multiple Integrals. Vector Calculus: Vector Fields, Line Integrals, Conservative Vector Fields, Green's Theorem, Surface Integrals, Divergence Theorem, Stokes' Theorem.

Books Recommended:

1. Calculus: Early Transcendentals - H. Anton, I. Bivens and S. Davis, Wiley.
2. Calculus and Analytic Geometry - G. B. Thomas and R. L. Finney, Addison Wesley.
3. Calculus: Early Transcendentals - J. Stewart, Thomson Brooks/Cole.
4. Calculus - R.T. Smith and R. B. Minton, McGraw-Hill Education

RME 2105: Managerial and Engineering Economics – 3 Credit

Introduction: Economics, Wants and Scarcity, Macro and Micro Economics, Methods used in Microeconomics, Microeconomic Models, Basic Concepts used in Economics.

The Market Forces of Supply and Demand: Demand Schedule and Demand Curve, Law of Demand, Supply Schedule and Supply Curve, Law of Supply, Market Equilibrium, Government Intervention and its Effect, Consumer and Producer Surplus.

Theory of Consumer Behavior and Demand: Utility, Marginal and Total Utility, Indifference Curves, Budget Line, Utility Maximization, Income–Consumption Curve, Normal and Inferior Goods, Substitution Effect and Income Effect.

Elasticity and its Application: Price and Income Elasticity of Demand, Cross-Price Elasticity of Demand, Price Elasticity of Supply.

Production Theory and the Costs of Production: Costs, Total Revenue, Total Cost and Profit, Opportunity Cost, The Production Function, Total-Cost Curve, Fixed and Variable Costs, Average and Marginal Cost, Costs and Profit Maximization, Return to Scale, Monopoly, Oligopoly, Monopolistic Competition.

Externalities and Market Inefficiency: Negative and Positive Externalities, Public Policies toward Externalities, Private Solutions to Externalities, Public Goods and Common Resources, The Tragedy of the Commons, Property Rights.

Market Failure and Solutions: Information Asymmetry, Adverse Selection, Moral Hazard, Principal-Agent Problem.

Concepts of Macroeconomics: GDP, GNP, National Income Accounting, Inflation, Unemployment, Fiscal and Monetary Policies.

Books Recommended:

1. Managerial Economics in a Global Economy - Dominick Salvatore, Oxford University Press.
2. Managerial Economics – William F. Samuelson, Stephen G. Marks, Wiley.

RME 2106: Society and Technology – 3 Credit

History and Philosophy of Science and Technology: Paradigm and the Structure of Scientific Revolutions.

Approaches to Studying Society and Technology Relationship: Technological Determinism, Social Determinism, Social Construction of Technology (SCOT), Actor Network Theory (ANT).

Transition Theory and Socio-technological Pathways: Niche Formation, Regime and Landscape.

Diffusion Theory: The Nature of Technological Diffusion into the Society Attributes of Innovation and their Rate of Adoption.

Technology and Public Participation: Types of Participation, Ladder of Citizen Participation, Stages of Market Participation, Mutual Shaping of Participation and Technology.

Professional Ethics: Ethics of Technology Design and Use, Regulatory Issues in Governing Technologies.

Use and Impact of Technologies in Various Social Aspects: Risks and Uncertainties, Bio-medical and Genetic Technologies, Robotics in Warfare or Replacement of Workforce, Social Media Effect, Artificial Intelligence.

Books Recommended:

1. People, Science and Technology: A Guide to Advanced Industrial Society – C. Boyle, P. Wheale and B. Surgess, Wheatsheaf Books Ltd.
2. Technology and Public Participation, Science and Technology Studies – B. Martin, University of Wollongong.
3. The Structure of Scientific Revolutions – T Kuhn, The University of Chicago Press.
4. Of Bicycles, Bakelites and Bulbs: Towards a Theory of Sociotechnical Change – W. E. Bijker, The MIT Press.
5. Risk Society: Towards a New Modernity – U. Beck, SAGE Publications.
6. Ethics in Engineering – M. W. Martin and R. Schinzinger, TATA McGraw-Hill.

RME 2111: Instrumentation and Measurement Lab – 1.5 Credit

Practical Classes based on the Topics Covered in **RME 2101**.

RME 2112: Digital Logic Circuit and Microprocessor Lab – 1.5 Credit

Practical Classes based on the Topics Covered in **RME 2102.**

Semester-IV (Second Year Second Semester)

RME 2201: Introduction to Robotics – 3 Credit

Introduction: Definition and Classification of Robots, Laws of Robotics, Applications of Robots, Basic Components of Robot Systems.

Mechanical Design of Robots: Links and Joints, Kinematic Chain, Mechanisms and Machines, Degrees of Freedom, Robot End Effectors.

Spatial Descriptions and Transformations: Description of Position, Orientation and Frames, Homogeneous Transformations.

Manipulator Kinematics: Link Parameters and Link Co-ordinate Systems, D-H Homogeneous Transformation Matrices, Forward and Inverse Kinematics of Serial Manipulators.

Manipulator Dynamics: Recursive Newton-Euler Formulation of Serial Manipulator, Lagrangian Formulation of Serial Manipulator.

Jacobian Analysis: Link Differential Transformation Matrix, Manipulator Jacobian Matrix, Conventional and Screw Based Jacobian of Serial Manipulator.

Robot Control Architecture: Trajectory Planning, Control of Manipulators, Motor Control, Robot Sensors, Low Level Robot Vision, Robot Programming.

Books recommended:

1. Modeling and Control of Robot Manipulators - Sciavicco and Siciliano, McGraw-Hill
2. Introduction to Robotics: Mechanics and Control - John J. Craig, Pearson Prentice Hall.
3. Robot Analysis - Lung-Wen Tsai, Wiley & Sons Inc.

RME 2202: Microcontroller and Programmable Logic Controller – 3 Credit

Microcontroller:

Introduction: Basics of Microcontroller, Architecture of Microcontroller, Evolution of Microcontroller, Microcontroller Family.

The 8051 Microcontroller: Features, Architecture of 8051, Block Diagram of 8051, I/O Ports, Functions of Each Pin of 8051.

Registers and their Functions of 8051: General Purpose and Special Function Registers.

Timer and Counter: Timer Registers, Timer Control Register (TCON), Timer Mode Control Register (TMOD).

Interfacing with External Memory: Memory Capacity, Memory Organization, Speed, Interfacing External ROM, Real World Interfacing.

8051 Instruction Set: Data Transfer Instructions, Arithmetic Instructions, Logical Instructions, Branching and Control Transfer Instructions, Arithmetic and Logical Operations, Subroutines, Addressing Modes.

Programming and Applications of Microcontroller: Programming for Speed Control of a DC Motor, Flushing an LED, Case Studies.

Programmable Logic Controller:

Fundamentals of PLC: Basic Functional Components of PLC, Applications, Importance, Classification, Comparison of PLC with Relay Panel.

Internal Architecture of PLC: Hardware, Block Diagram and Operation of PLC, Memory, Storage Capacity, Bus System.

Communication between PC and PLC: Serial Communication, Ethernet, IOT etc.

Ladder Programming: Ladder Programming Conventions, Logic Functions, Latching, Sequencing.

Types of Instructions: Timer/Counter Instructions, Logical Instructions, Compare Instructions, Move Instructions, Program Control Instructions.

PLC Programming: Motor Control using PLC, Central Heating System, Robot Control System.

Books Recommended:

1. 8051 Microcontroller: Hardware, Software and Applications - V Udayashankara & M S Mallikarjunaswamy, Tata McGraw Hill.
2. The 8051 Microcontroller - Kenneth J. Ayala, Thomson Delmer Learning.
3. The 8051 Microcontroller and Embedded Systems: Using Assembly and C - Mazidi Muhammad Ali, Pearson Education.
4. Microprocessors and Microcontrollers - N. Senthil Kumar, OUP India.
5. Programmable Logic Controller - Frank D. Petro Zella, McGraw Hill Publications.

RME 2203: Object Oriented Programming – 3 Credit

Introduction: Object Oriented Programming Overview, Encapsulation, Inheritance and Polymorphism. Object Oriented vs. Procedural Programming, Basics of Object Oriented Programming Language.

Objects and Classes: Attributes and Functions, Constructors and Destructors, The Default Copy Constructor, Static Class Data, Operator Overloading, Function Overloading.

Inheritance: Derived Class and Base Class, Derived Class Constructors, Overriding Member Functions, Abstract Base Class, Public and Private Inheritance, Multilevel Inheritance, Multiple Inheritance, Ambiguity in Multiple Inheritance

Virtual Functions: Virtual Functions, Pure Virtual Functions, Static Binding, Dynamic Binding, Friend Functions, Static Functions, Friend Class.

Stream and files: Stream Classes, ios Class, istream Class, ostream Class, Stream Errors. Disk File I/O with Streams, File Pointers.

Exception and Exception Handling: Exception Handling Fundamentals, Exception Types, Chained Exception, Creating Own Exception Subclasses.

Books Recommended:

1. Teach Yourself C++ - Herbert Schildt, Tata McGraw-Hill Education.
2. Object-Oriented Programming in C++ - Robert Lafore, Techmedia.
3. Java in a Nutshell – David Flanagan, Cambridge, MA: O'Reilly.

RME 2204: Electrical Machines - 3 Credit

Electromechanical Energy Conversion Fundamentals: Faraday's Law of Electromagnetic Induction, Fleming's Rule and Lenz's Law.

Single Phase Transformer: Working Principle, Construction, Types, EMF Equation, Transformer on No Load and On Load, Vector Diagram.

DC Generator: Types, No-Load Voltage Characteristics, Build-Up of a Self Excited Shunt Generator, Critical Field Resistance, Load-Voltage Characteristic, Effect of Speed on No-Load and Load Characteristics and Voltage Regulation.

Synchronous Generator: Excitation Systems, Equivalent Circuit, Phasor Diagrams at Different Loads, Factors Affecting Voltage Regulation, Synchronous Impedance, Synchronous Impedance Method of Predicting Voltage Regulation and its Limitations.

D.C. Motor: Construction, Principle of Operation, Torque/Speed Characteristics, Losses and Efficiency.

Three Phase Induction Motor: Construction, Types, Rotating Magnetic Field, Principle of Operation, Slip, Frequency of Rotor Current, Rotor emf, Rotor Current, Expression for Torque,

Conditions for Maximum Torque, Torque Slip Characteristics, Effect of Change in Supply Voltage on Torque, Relation between Full Load Torque and Maximum Torque.

Synchronous Motor: Principle of Operation, Method of Starting, Equivalent Circuit, Equation of Power and Torque, Effect of Loading under Different Excitation Condition, Effect of Changing Excitation.

Books Recommended:

1. Alternating Current Machines – A. F. Puchstein, T. C. Lioyd and A. G. Conrad, John Wiley & Sons.
2. A Text Book of Electrical Technology- B.L. Theraja and A.K. Theraja, S Chand & Company Ltd.
3. Electric Machinery Fundamentals - Stephen J. Chapman, McGraw-Hill Education.

RME 2205: Differential Equations and Coordinate Geometry - 3 Credit

Differential Equations:

Ordinary Differential Equations: Order and Degree of an Ordinary Differential Equation, Classification of Differential Equations, Solutions of Differential Equations, Formation of Differential Equations, Basic Existence and Uniqueness Theorem (Statement and Illustration Only).

First Order Differential Equations: Separable Equations, Homogeneous Equations, Exact Differential Equations, Linear and Bernoulli Equations, Special Integrating Factors, Substitutions and Transformations.

Higher Order Differential Equations: Basic Theory of Linear Differential Equations, Reduction of Order, Homogeneous Linear Equations with Constant Coefficients, Non-Homogeneous Equations (Method of Undetermined Coefficients, Variation of Parameters, Cauchy-Euler Differential Equations).

Coordinate Geometry:

Two-dimensional Geometry: Coordinates in Two Dimensions, Change of Axes, Transformation of Coordinates, General Equation of Second Degree (Pair of Straight Lines, Identification of Conics).

Three-dimensional Geometry: Coordinates in Three Dimensions, Direction Cosines and Direction Ratios, Equations of Planes and Lines.

Books Recommended:

1. Differential Equations - Shepley L. Ross, Wiley.
2. A First Course in Differential Equations with Applications - D. G. Zill, International Thomson Publishing.

3. Analytic Geometry and Vector Analysis - A.F.M. Abdur Rahman, P.K. Bhattacharjee.
4. Analytic Geometry and Vector Analysis - Khosh Mohammad.

RME 2206: Statistics for Engineers – 3 Credit

Basic Statistics: Basic Concept of Statistics, Classification and Tabulation, Frequency Distribution and Construction of Frequency Distribution, Statistical Graphs for Frequency Distributions.

Measures of Central Tendency: Mean, Median, Mode, Quartile, Percentile.

Measures of Variation: Range, Mean Deviation, Standard Deviation, Co-Efficient of Variation.

Simple Correlation and Liner Regression Models: Measures of Correlation, Scatter Diagram, Karl Pearson's Correlation Coefficient – Properties, of Karl Pearson's Correlation Coefficient, Spearman's Rank Correlation Coefficient, Multiple Correlations, Regression – The Method of Least Squares, Inferences Based on Least Square Estimators.

Probability: Sample Spaces and Events, Theorems of Probability, Conditional Probability, Mathematical Expectation, Joint Probabilities and Independence, Bayes' Theorem, Law of Large Numbers, Central Limit Theorem, Chebyshev's Inequality.

Probability Distributions: Random Variables, Joint Probability Distribution, Bernoulli Distribution, Binomial Distribution- Assumptions for Applying a Binomial Distribution – Approximation of The Binomial Distribution, Poisson Distribution - Assumptions for Applying The Poisson Distribution, The Uniform Distribution, Normal Distribution - Standard Normal Distribution, Exponential Distribution.

Inferences / Testing of Hypothesis: Point Estimation, Bayesian Estimations, Null Hypothesis, Test Statistics, Type I And II Errors, Level of Significance, One-Tailed And Two-Tailed Tests, P-Value, Power of a Test, Confidence Intervals, Hypothesis Test Concerning One and Two Population Mean, Hypothesis Test Concerning One and Two Population Proportions, Tests about a Population Variances.

Books Recommended:

1. An Introduction to Statistics and Probability – M. N. Islam, Book World
2. Probability and Statistics for Engineers and Scientists – Ronald Walepole and Raymond H. Myers, Pearson.

RME 2211: Introduction to Robotics Lab – 1.5 Credit

Practical Classes based on the Topics Covered in **RME 2201.**

RME 2212: Microcontroller and Programmable Logic Controller Lab – 1.5 Credit

Practical Classes based on the Topics Covered in **RME 2202.**

RME 2213: Object Oriented Programming Lab – 1.5 Credit

Practical Classes based on the Topics Covered in **RME 2203.**

Semester-V (Third Year First Semester)

RME 3101: Artificial Intelligence – 3 Credit

Introduction: Agents and Environment.

Problem Solving by Searching: Un-Informed Search Strategies: Breadth First Search, Uniform Cost Search, Depth-First Search, Iterative Deepening and Bidirectional Search. Informed Search Algorithms: Best-First Search, A* Search, Beam Search, Heuristic Searching, Memory Bounded Search. Local Searches: Hill Climbing, Simulated Annealing, Constraint Satisfaction Problems. Genetic Algorithm: Selection, Crossover, Mutation and Fitness. Game Playing: Motivation, Min-max Search, Resource Limits and Heuristic Evaluation, α-β Pruning.

Logic: Propositional, First Order Logic: Quantifiers, Model, Validity, Inference, Substitution, Unification and Herbrand Theorem, Fuzzy Logic.

Machine learning: Supervised Learning, Decision Trees, Reinforcement Learning, Q-learning.

Planning: Planning Problems, Partial Order Planning, Planning as Logical Inference Planning.

Probabilistic Reasoning: Uncertainty, Probability, Independence, Bayes' Rule, Bayesian Network, Exact Inference in Bayesian Network and Approximate Inference.

Knowledge Representation: Ontological Engineering, Categories and Objects, Events, Reasoning Systems for Categories.

Application: Robotics: Hardware, Perception, Learning, Interaction.

Books Recommended:

1. Artificial Intelligence: A Modern Approach – S. Russell and P. Norvig, Pearson Education.
2. Artificial Intelligence – E. Rich and K. Knight, Mc-Graw Hill
3. Natural Language Understanding – J. Allen, Pearson Education.
4. Artificial Intelligence – P. H. Winston, Addison-Wesley.
5. Prolog Programming for Artificial Intelligence - Ivan Bratko, Pearson Education.

RME 3102: Advanced Mechatronics Engineering – 3 Credit

Introduction: Identification of Software into Mechatronics Systems, Identify Types of Industrial Sensors in Mechatronics System, Advanced Applications of PLC, Advanced Applications of Microcontroller.

Control System in Mechatronics: Actuation Principles, Control Systems and its Role in Mechatronics.

Interfacing: Interfacing of Software with Hardware, Real-time Computation Tasks.

Mechatronic Systems Design: Integrating PLC with Cognex Vision System, Microelectromechanical Systems (MEMS), Machine Vision, Industrial Automation and Robotics.

Case Studies: Systematic Approach in Design Process of Mechatronic Systems, Innovative Mechatronic Product Design, Autonomous Wireless Systems, Monitoring and Control of Mechatronic Systems.

Books Recommended:

1. Mechatronics Engineering - Sastry, Tata McGraw Hill.
2. Mechatronics – Sabri Cetinkunt, Wiley.
3. Automatic Control Engineering -F.H.Raven, McGraw Hill International.
4. Modern Control Engineering - K.Ogata, Prentice Hall.

RME 3103: Mechanics of Solids and Fluids - 3 Credit

Mechanics of Solids:

Introduction to Solid Mechanics: Concept of Stresses and Strains, Hooke's Law, Stress-Strain Diagram.

Stress and Strain Analysis: Axially Loaded Members, Statically Indeterminate Problems, Thermal Stress, Stresses in Thin Walled Cylinder.

Torsion: Torsion Formula, Angle of Twist, Stresses in Helical Springs.

Beams: Shear and Bending Moment Diagrams, Flexure and Shear Stresses in Beams, Deflection of Beams- Double Integration Method.

Columns: Definition and Types, Critical Load and Euler's Formula, Critical Stress and Slenderness Ratio, Intermediate Column Formulas, Secant Formula.

Combined Stresses: Principal Stresses, Mohr's Circle.

Mechanics of Fluids:

Introduction to Fluid Mechanics: Development and Scope of Fluid Mechanics, Fluid Properties, Flow Properties, Newtonian and Non-Newtonian Fluids.

Static's and Kinematics of Fluid Flow: Manometry, Forces on Submerged Surfaces, Buoyant Force, Stability of Floating and Submerged Bodies, Different Types of Fluid Flow, Velocity and Acceleration of Fluid.

Dimensional Analysis and Similitude: Different Methods of Dimensional Analysis, Geometric, Kinematic and Dynamic Similarity, Dimensionless Numbers in Fluid Mechanics.

Fluid Flow Concepts and Basic Equations: Continuity Equation, Bernoulli's Energy Equation, Momentum Equation, Laminar and Turbulent Flows, General Equation for Fluid Friction.

Flow through Pipes: Empirical Equations for Pipe Flow, Losses in Pipes and Fittings.

Fluid Flow Measurement Techniques: Pitot Tube, Nozzle, Orifice Meter, Venturi Meter, Weir etc.

Books Recommended:

1. Strength of Materials - Andrew Pytel and Ferdinand L. Singer, Harpercollins College Div.
2. Mechanics of Materials - Ferdinand P. Beer, Elwood Russell Johnston and John T. DeWolf, McGraw-Hill Higher Education.
3. Mechanics of Materials - Egor Paul Popov, Sammurthy Nagarajan and Zung An Lu, Prentice-Hall.
4. Fluid Mechanics - Frank White, McGraw-Hill Education.
5. Fluid Mechanics: Fundamentals and Applications - Yunus A. Çengel and John M. Cimbala, McGraw-Hill Education.
6. Fluid Mechanics through Worked out Problems - Dr. Md. Quamrul Islam, IUT.

RME 3104: Mathematical Analysis for Engineers – 3 Credit

Numerical Analysis: Errors in Numerical Analysis. Solutions of Equations in One Variable- Bisection Method, Method of False Position, Fixed Point Iteration Method, Newton-Raphson Method. Interpolation- Newton's Forward and Backward Difference Interpolating Polynomials. Numerical Differentiation. Numerical Integration- Trapezoidal Rule and Simpson's Rule. Initial Value Problems for ODE- Euler's and Modified Euler's Method, Runge-Kutta Method.

Laplace Transforms: Forward Transform, Inverse Transform. Examples of Transform Pairs. The Laplace Transform of a Differential Equation. The Use of Laplace Transforms for the Solution of Initial Value Problems, Existence and Uniqueness of Laplace Transforms.

Fourier Transforms: Properties of Fourier Series, Fourier Sine and Cosine Series, Fourier Transform of Continuous and Discrete Signals, Fourier Coefficients and Orthogonally, Generally Periodic Functions, Odd and Even Functions, Fourier Transform of Continuous and Discrete Signals and the Discrete Fourier Transform and the FFT Algorithm.

Books Recommended:

1. Numerical Analysis - R. L. Burden, J. D. Faires and A. M. Burden, Cengage Learning.
2. Numerical Methods for Engineers - S. C. Chapra and R. P. Canale, McGraw-Hill Education.
3. Introductory Methods of Numerical Analysis - S. S. Sastry, Prentice Hall India.

4. An Introduction to Laplace Transforms and Fourier Series- Phil Dyke, Springer Science & Business Media.
5. Advanced Engineering Mathematics - E. Kreyszig, Wiley.
6. Laplace Transforms - M. R. Spiegel, Schaum's Outline Series.

RME 3105: Industrial Management – 3 Credit

Industrial Dynamics and the Interplay with Competitors and Stakeholders (Customers, Suppliers, Employees, the Society at Large and so on), the Distinctive Character of Industrial Operations, Organization and Human Resource Management, Innovation and Entrepreneurship, Leadership, Strategic Planning, Marketing, Cost-Volume-Profit Analysis, Finance (Supply and Use of Capital), Cash-Flow Analysis, Investment Appraisal, Management Control, and Costing.

Books Recommended:

1. Personal Management - C.B. Memorria and S. V.Gankar, Himalaya Publishing House.
2. Financial Management - Khan & Jain, ata McGraw-Hill Education.
3. Management for Engineers: Technologists and Scientists - W Nel, John Wiley & Sons.
4. Management for Engineers - AC Payne, JV Chelson and LRP Reavill, Wiley and Sons.

RME 3111: Artificial Intelligence Lab – 1.5 Credit

Practical Classes based on the Topics Covered in **RME 3101**

RME 3112: Advanced Mechatronics Engineering Lab – 1.5 Credit

Practical Classes based on the Topics Covered in **RME 3102**

RME 3113: Mechanics of Solids and Fluids Lab – 1.5 Credit

Practical Classes based on the Topics Covered in **RME 3103**

Semester-VI (Third Year Second Semester)

RME 3201: Intelligent Systems and Robotics - 3 Credit

Introduction to Intelligent Systems (Current and Future), Potential Applications of Intelligent Systems and Robotics, Knowledge Based Systems, Expert Systems, Agents and Agent Systems, Robotics and Control Systems, Neural Networks, Artificial Neural Networks, Attribute-Based Learning, Relation-Based Learning, Probability-Based Learning, Surprise-Based Learning, Hybrid Intelligent Systems, Uses and Limitations. Robot Behaviors, Behavior-Based Architecture, Clustering and Classification Techniques, Philosophy and Ethics of Intelligent Systems in Robotics.

Books Recommended:

1. An Introduction to AI Robotics – Robin R. Murphy, Bradford Book.
2. Artificial Intelligence: A Modern Approach – Russell S. & Norvig P., Pearson Education.
3. Robotics: Control, Sensing, Vision and Intelligence - Ralph Gonzalez, C.S.G. Lee and K. S. Fu, McGraw Hill India.
4. Intelligent Systems and Robotics - George Zobrist, C Y Ho, CRC Press.

RME 3202: Manufacturing Process with CNC Programming – 3 Credit

Introduction: Basic Concepts of Manufacturing Processes, Classification of Manufacturing Processes.

Metal Casting: Casting Processes for Ferrous and Non-Ferrous Metals, Casting Defects, Design of Molds, Riser, Gate Sprue and Core.

Joining Methods: Soldering, Brazing, Welding- Gas, Arc, TIG, MIG etc.

Different Machining Processes: Various Operations, Cutting Tools and Their Analyses in Turning, Milling, Drilling, Shaping, Grinding etc.

Forming and Shaping: Sheet Metal Forming, Punching, Blanking, Drawing, Injection Molding, Compression Molding, Blow Molding etc.

Introduction to CNC: Introduction to the Fundamentals of Computer Numerical Controlled (CNC) Milling Machines and their Programming. Basic Operation of CNC Machines, CNC Machine Safety, Simulation, Tooling with Tool Selection, and Machine Zeroing. Absolute and Incremental Positioning, Circular Interpolation, Program Interpolation, and Cycle Pausing.

CNC Machine Operation: Machine Speeds and Feeds, Feed Rate, and Cycle Time Optimization, Drilling Cycles, Subprograms, Cutter Compensation, and Scaling/Mirroring, CAM-Mill Processes, Contouring, Cycle Time Estimation, Tool Selection, Material Selection, Cutter Compensation, Contour Applications, Roughing, Finishing and Tool Paths.

Books Recommended:

1. Manufacturing Processes and Materials for Engineers – Laurence E. Doyle, Prentice Hall.
2. Manufacturing Processes – B. Stuad and H. Amsteard, McGraw Hill.
3. Manufacturing Process – B.H. Amstead and Philip F. Ostwald, John Wiley and Sons.
4. Manufacturing Processes for Engineering Materials - Serope Kalpakjian and Steven Schmid, Pearson.

RME 3203: Power Electronics and Drives - 3 credit

Introduction: Fundamentals of Power Electronics and Drives.

Power Electronics:

Devices: Thyristor, Triac.

Power Amplifiers: Classification of Output Stages.

AC/AC Power Converters: Phase Controlled Converters - Single Phase and Three Phase, AC Switch, Cycloconverter.

DC/DC Converters: Choppers (Step Down and Step Up), Switching Regulators (Buck, Boost, Buck-Boost).

DC/AC Converters: Single Phase and 3-Phase Inverters.

Power Supplies: Linear and Switched Mode Power Supplies.

Drives:

Motor Drives: Vector and Servo Drives (Stepper, DC, Induction, Brushless PM and Switched-reluctance).

Sensors and Communication: Types of Sensors used for Velocity and Position Feedback on Modern Drive Systems, Characteristics of the Operation of Motor and Amplifier Combinations using Two Types of Sensor Feedback.

Books Recommended:

1. Power Electronics – C. W. Lander, McGraw Hill.
2. Power Electronics – D. A. Bradley, CRC Press.
3. Principle of Electronics -V. K. Mehta, S Chand & Company Ltd.
4. Electronic Devices and Circuits - Jacob Millman and Christos C. Halkias, McGraw Hill.
5. Operational Amplifier and Linear Integrated Circuits – Robert F. Coughlin and Frederick F. Driscoll, Prentice Hall.

RME 3204: Control Systems Design – 3 Credit

Introduction: Introduction to Control Systems and their Representation by Different Equations.

Transfer Functions: Laplace Transforms, Mathematical Model of Physical System, PI and PID Controllers, Hydraulic and Pneumatic Controllers, Time Domain Analysis, Transient Response of First and Second Order Systems.

Introduction to Nonlinear Control: State Space Analysis, Optimal and Adaptive Control, Introduction to Discrete-time Systems and Z-transform.

Modern Control System: Concepts of States, State Variable and State Models Linear Continuous Time and Discrete Time, State Space Models, Similarity Transformation, Transform Function to State Space Representation, Controllability and Stabilizability, Absorbability and Detectability Canonical Decomposition, Polo Assignment by State Feedback. Observers, Continuing State Feedback with an Observer.

Controller and Final Control Element: Control Valves, Controller Configuration, System Control, System Design, Common Control Methodologies - P, D, I, PI, PD and PID.

Books Recommended:

1. Modern Control Systems – R. C. Dorf and R. H. Bishop, Addison Wesley.
2. Automatic Control System - Benzamin C. Kuo, Prentice Hall.

RME 3205: Bangladesh Studies – 2 Credit

History: Historical Background of Bangladesh, Ancient Bengal, the Medieval Bengal, Mughal Period, British Rule in Bangladesh, Pakistan Period, The Impact of British and Pakistan Rules on the Economy and Education of the People, Language Movement of 1952, Events Leading to the Mass Upsurge of 1969, War of Independence and the Emergence of Bangladesh in 1971.

Geophysical Condition: Position of Bangladesh in Global Map, Current District and Thana Administrations and Locations, Rivers in Bangladesh and their Importance.

Cultural Development: Development of Bengali Cinema, Drama, Literature Movement, Socio-cultural Development in Recent Bangladesh.

Industrial Development: Introduction of Industries, Structure of Industries, Export Development, Industrial Export-Import Policies of Bangladesh.

Educational Development: Education Structure in Primitive and Present Situation, Educational Policies, Crisis of Implementation, Literacy Rate, Current Situation of Educational Environment in Bangladesh, Computer Literacy.

Economic Activities: Major Economic Sectors, Trends of Economic Growth, Recent Development in Various Sectors, Rule Agricultural Sector, RMG Sector, Leather Sector, Frozen Foods and other Potential Sectors in Bangladesh, Transport and Port Facilities.

Books Recommended:

1. History of Bangladesh (1704-1971): Vol 1, 2, 3, Asiatic Society of Bangladesh.
2. History of Bengal: Vol 1, 2, Dhaka University.
3. History of the Bengali speaking people - Nitish Sen Gupta. Ubs Pub Distributors Ltd.
4. Banglapedia: Asiatic Society of Bangladesh.

RME 3211: Intelligent Systems and Robotics Lab – 1.5 Credit

Practical Classes based on the Topics Covered in **RME 3201**.

RME 3212: Manufacturing Process with CNC Programming Lab – 1.5 Credit

Practical Classes based on the Topics Covered in **RME 3202**.

RME 3213: Power Electronics and Drives Lab - 1.5 credit

Practical Classes based on the Topics Covered in **RME 3203.**

Semester-VII (Fourth Year First Semester)

RME 4101: Advanced Robotics – 3 Credit

Introduction: Robotic Systems, System Interface, Engineering Tools to Design Robots.

Structural Robot Design: Statics and Stiffness Analysis of Serial and Parallel Manipulators, Wrist Mechanisms, Gripper Design.

Kinematics of Parallel Manipulators: Forward and Inverse Kinematics of Parallel Manipulators.

Dynamics of Parallel Manipulators: Newton-Euler Formulation and Lagrangian Formulation of Parallel Manipulators.

Jacobian Analysis of Parallel Manipulators: Singularity Conditions, Conventional and Screw Based Jacobian of Parallel Manipulators.

Case Studies to Design a Robotic System.

Books recommended:

1. Robotics: Designing the Mechanisms for Automated Machinery - Ben-Zion Sandier, Academic Press.
2. Modern Robotics: Building Versatile Machines, Harry Henderson, Chelsea House Publications.
3. Modelling and Simulation of Robot manipulators: A Parallel Processing Approach – Albert Y. Zomaya, World Scientific Publishing Co.
4. Robot Analysis - Lung-Wen Tsai, Wiley & Sons Inc.

RME 4102: Digital Image Processing and Robot Vision – 3 Credit

Introduction: Introduction to Image Processing and Robot Vision, Applications of Image Processing, Differences between Image Processing, Image Analysis and Robot Vision, Digital Image representation, Color Space, Types of Images.

Image Acquisition: Image Sampling and Quantization, Image Quality, Image Storage.

Image Processing: Image Quality Enhancement: Intensity Transformations, Contrast Stretching, Histogram Equalization, Spatial Domain Filtering - Mean and Median Filters, Sharpening Filters - Laplacian and Sobel, Image Restoration - Noise Models, Spatial and Frequency Filters, Morphological Image Processing.

Image Transforms: Discrete Fourier Transform, Fast Fourier Transform, Discrete Cosine Transform, Wavelet Transform,

Image Feature Extraction and Representation: Edge and Line, Region Segmentation and Representation, Image and Video Compression.

Object Recognition: Pattern and Pattern Classes, Template Matching, Statistical Methods, Biometric Case Studies - Face, Iris, Fingerprint Recognitions.

Vision: Vision-Based Estimation, Calibration and Localization. Vision-Based Robot Navigation

Books Recommended:

1. Digital Image Processing - Rafael C. Gonzalez, Richard E. Woods, Pearson.
2. Computer Vision: Algorithms and Applications - Richard Szeliski, Springer.
3. Robot Vision - Berthold K. P. Horn, The MIT Press.

RME 4103: Digital Signal Processing – 3 Credit

Signal, System and Processing, Advantages and Limitations of DSP, Components of DSP, Classification of Signals, Discrete-time Signals and Systems, Analog to Digital Conversion, Impulse Response, Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) of Discrete-time Systems, Difference Equation, Convolution, Transient and Steady State Response Discrete Transformations: Discrete Fourier Series, Discrete-time Fourier series, Discrete Fourier Transform (DFT) and Properties, Fast Fourier transform (FFT), Inverse Fast Fourier Transform, Z

Transformation - Properties, Transfer Function, Poles and Zeros and Inverse Z Transform. Correlation: Circular Convolution, Autocorrelation and Cross-correlation. Digital Filters: FIR Filters - Linear Phase Filters, Specifications, Design using Window, Optimal and Frequency Sampling Methods.

Books Recommended:

1. Digital Signal Processing- John G. Proakis and Dimitris G. Manolakis, Prentice Hall.
2. Digital Signal Processing – Alan V. Oppenheim and Ronald W. Schafer, Pearson.

RME 4104: Mechanical Power Transmission Systems – 3 Credit

Power Transmission Devices: Introduction to Mechanical Drive Systems and Components, Design and Analysis of Spur and Helical Gears, Cam Design, Design of Power Transmission Shafts, Roller Contact and Journal Bearings, Brakes and Clutches.

Power Transmission Systems: Gear Trains, Belt, Rope and Chain Drives, Hydraulic Drive Systems, Efficiency of Different Power Transmission Systems.

Couplings: Types and Functions of Couplings Used in Industrial Power Transmission Systems.

Converters: Fluid, Electrical and Mechanical Converters.

Case Studies Based on the Application of Mechanical Power Transmission Systems.

Books Recommended:

1. Theory of Machines- R.S. Khurmi, J.K. Gupta, Eurasia Publishing House.
2. Shigley's Mechanical Engineering Design- Richard Gordon Budynas, J. Keith Nisbett, McGraw Hill.
3. The Characteristics of Mechanical Engineering Systems – R Holmes, Pergamon.
4. Total Design – S Pugh, Addison Wesley.
5. Handbook for Engineering Design – PER Mucci, BSI.

RME 4111: Advanced Robotics Lab – 1.5 Credit

Practical Classes based on the Topics Covered in **RME 4101.**

RME 4112: Digital Image Processing and Robot Vision Lab – 1.5 Credit

Practical Classes based on the Topics Covered in **RME 4102**.

RME 4113: Digital Signal Processing Lab – 1.5 Credit

Practical Classes based on the Topics Covered in **RME 4103**.

RME 4115: Research Methodology, Technical and Scientific Writing Lab – 1.5 Credit

Introduction: Definition of Research, Objectives, Motivation, Concept and Importance in Research, Features of a Good Research Design.

Types of Research: Qualitative and Quantitative Research, Fundamental Research, Applied Research, Engineering Research.

Methodologies for Research: Research Proposals, Research Planning, Legal Research.

Research Ethics: Ethichal Issues Related to Publishing, Plagiarism and Self Plagiarism, Uses of References, Copyright.

Scientific Paper/Report/Thesis Writing: Layout of a Research Paper, Making Effective Charts, Graphs, Tables, Accuracy Clarity, Simplicity, Precision, Logic, Style, Language, Editing and Proof Reading, Impact Factor of Journals, Hands on Training on Latex.

Skills: Presentation Skills and Communication Skills.

Books Recommended:

1. Research Methodology: A Step-by-Step Guide for Beginners - Ranjit Kumar, SAGE Publications Ltd.
2. Research Methodology: Methods and Techniques - C. R. Kothari, New Age International Pvt Ltd.
3. An Introduction to Research Method - M. Nurul Islam.
4. Research Planning and Proposal Writing Skill - Dr. Subrota Kumar Saha.

RME 4100: Project – 2 Credit

In this course, students are required to undertake a major project in engineering analysis, design development of research. The objective is to provide an opportunity to develop initiative, self-reliance, creative ability and engineering judgment. In this semester, students will submit their intermediate work and in the next semester (Semester VIII) they will submit the final projectwork (RME 4200).

Semester-VIII (Fourth Year Second Semester)

RME 4201: Human Robot Interaction – 3 Credit

Overview of Social Robots, Anthropomorphism and Design, HRI Today, HCI and Human Factors, Human-Robot Relations, Sensors and Perception for HRI, Expression and Gaze, Multi-modal Human-Robot Communication, Human-Robot Interaction Architectures, HRI Design Principles, Metrices for HRI, Social Learning, Motivation and Emotions in Robotics, Emotional Intelligence, Ethics and War, Educational Robotics, Assistive Robotics, Case Studies.

Books Recommended:

1. Human-Robot Interactions: Principles, Technologies and Challenges - Diana Coleman, Nova Science Pub Inc.
2. Human-Robot Interaction in Social Robotics - Takayuki Kanda, Hiroshi Ishiguro, CRC Press.

RME 4211: Human Robot Interaction Lab – 1.5 Credit

Practical Classes based on the Topics Covered in **RME 4201**.

RME 4200: Project – 4 Credit

In this course, students are required to undertake a major project in engineering analysis, design development of research. The objective is to provide an opportunity to develop initiative, self-reliance, creative ability and engineering judgment. In this semester they will submit the final project work based on the intermediate submitted work (RME 4100) of the previous semester (Semester VII).

Optional Courses

Group-A

RME 4221: Introduction to Machine Learning - 3 Credit

Introduction: Introduction to General Concepts and Techniques of Machine Learning, Supervised and Unsupervised Learning.

Issues in Machine Learning: Parametric and Non-parametric Models, Curse of Dimensionality, Over-fitting and Model Selection.

Linear Models for Regression: Maximum Likelihood and Least Squares, Regularized Least Squares, Bias Variance Decomposition, Bayesian Linear Regression.

Linear Models for Classification: Fisher's Linear Discriminant, Probabilistic Generative Models - Parametric (Maximum Likelihood and Bayesian) and Non-parametric Density Estimation.

Probabilistic Discriminative Models: Logistic Regression, Log-linear Models, Kernel Methods and Sparse Kernel Machines. Clustering, Mixture Models and Expectation Maximization Algorithm. Sequential Data and Markov Models.

Applications of machine learning: Applications in robotic control, data mining, autonomous navigation, bioinformatics, speech recognition, and text and web data processing.

Books Recommended:

1. Introduction to Machine Learning - Ethem Alpaydin, MIT Press.
2. Machine Learning: An Algorithmic Perspective - Stephen Marsland, Chapman and Hall.
3. Pattern Recognition and Machine Learning - Christopher M. Bishop.
4. Machine Learning - Tom Mitchell, McGraw Hill.

RME 4222: Introduction to Biomedical Engineering - 3 Credit

Electromagnetic and Biology: Fundamentals of Electric and Magnetic Fields, Electric and Magnetic Fields in Biological Systems, Electric and Magnetic Field Effects in Organisms, Electric Fields and Cells, Electrical Properties of the Membrane, Cell Motion in Time-varying Fields, Nuclear Medicines, Biosensors, Bio-electrodes, Ultrasonography, Blood Pressure Measurement, X-rays, Crystallography.

Applications of Electric Fields for Bio-analysis Methods Applied to Genomic and Protomic Research: Electrophoresis and Isoelectric Focusing, Mass Spectrometry of Bio-molecules.

Electrocardiography (ECG): Waveform, ECG Preamplifiers, Systolic, Diastolic and Mean Detector Circuits.

Electroencephalography (EEG): Electrode, Frequency Bands, EEG Patterns and EEG Preamplifiers, Blood Flow Measurement, ICU / CCU Central Monitoring System, Radiation, Radioactivity and their Effects on Human Body.

Applications of Biomedical Engineering in Robotics.

Books Recommended:

1. Electrostatics Principles, Problems and Applications- Jean Cross, CRC Press.
2. Electromagnetics with Applications - John D. Kraus and Daniel A. Fleisch, McGraw Hill.
3. Electricity and Magnetism in Biological Systems – D. T. Edmonds, Oxford University Press.

RME 4223: Mobile Robotics - 3 Credit

Introduction: Introduction of Mobile Robotics, Types and Applications of Mobile Robots.

Kinematics: Kinematic Models for Front-wheel and Differential-drive Steering Vehicles.

Localization and Mapping: Vehicle State Estimation using Bayes Filters, Kalman Filters, and Particle Filters, Onboard Localization and Mapping.

Motion Planning: Types of Locomotion, Vehicle Motion Modelling, Graph Based and Probabilistic Motion Planning, Planning for Autonomous Operation.

Remote Sensing: Different Types of Sensors used in Mobile Robots, Sensor Modeling.

Mobile Robot Control: Heading and Speed Control, Reference Trajectory and Incremental Control.

Drone: Structure and Principles, Drone Flight Control and Operation, Drone Programming.

Case Studies.

Books Recommended:

1. Autonomous Mobile Robots -Siegwart and Nourbakhsh, MIT Press.
2. Mobile Robots: Navigation, Control and Remote Sensing - Gerald Cook. IEEE Press.

RME 4224: Simulation and Modeling - 3 Credit

Introduction: Basic Aspects of Simulation and Modeling, System Process/Models and Systems.

Simulation Basics: Handling Stepped and Event-based Time in Simulations, Discrete versus Continuous Modelling, Numerical Techniques, Sources and Propagation of Error.

Dynamical, Finite State, and Complex Model Simulations: Graph or Network Transitions Based Simulations, Actor Based Simulations, Mesh Based Simulations, Hybrid Simulations.

Converting to Parallel and Distributed Simulations: Partitioning the Data, Partitioning the Algorithms, Handling Inter-partition Dependencies.

Probability and Statistics for Simulations and Analysis: Introduction to Queues and Random Noise, Random Variates Generation, Sensitivity Analysis.

Simulations Results Analysis and Viewing Tools: Display Forms - Tables, Graphs, and Multidimensional Visualization, Terminals, X and MS Windows, and Web Interfaces, Validation of Model Results.

Books Recommended:

1. Discrete-Event System Simulation – J. Banks, J. S. Carson, B. L. Nelson and D. M. Nicol, Prentice Hall.
2. Simulation Modeling and Analysis – A. M. Law, W. D. Kelton, McGraw Hill International Series.
3. Queuing Analysis - William Stallings.

RME 4231: Introduction to Machine Learning Lab – 1.5 Credit

Practical Classes based on the Topics Covered in **RME 4221**.

RME 4232: Introduction to Biomedical Engineering Lab – 1.5 Credit

Practical Classes based on the Topics Covered in **RME 4222**.

RME 4233: Mobile Robotics Lab – 1.5 Credit

Practical Classes based on the Topics Covered in **RME 4223**.

RME 4234: Simulation and Modeling Lab – 1.5 Credit

Practical Classes based on the Topics Covered in **RME 4224**.

Group - B

RME 4225: Material Science and Engineering - 3 Credit

Introduction: Engineering Materials, Materials Cycle, Application and Selection Criteria of Materials.

Atomic Structure and Bonding: Elementary Particles, Electronic Distribution and Atomic Size/Structure, Bonding- Primary and Secondary, Effect of Bonding on Material Properties.

Structure of Solids: Crystallinity in Metals, Ceramics, Semiconductors and Polymers. Crystal System/Lattice/Structure- Crystallographic Indexing of Planes and Directions, Atomic Aggregates and their Structure, Significance of Microstructure, Amorphous Structure. Crystalline Defects- Dimensions, Origin and Their Effect on Properties.

Phase Diagrams: Origin, Construction, Interpretation and Application of Binary Phase Diagrams With Reference to a Few Important Metallic and Ceramic Systems, Iron-Iron Carbide Phase Diagram.

Properties of Materials: Physical, Mechanical, Chemical, Electrical, Semi/Super Conducting, Magnetic, Optical and Thermal Properties of Solids, Units and Testing.

Heat Treatment: Annealing, Normalizing and Hardening, Different Types of Surface Hardening Techniques, Metals and Alloys.

Engineering Materials: Structure, Properties, Processing, Fabrication and Application of- Metals and Alloys, Ceramics and Advanced Ceramics, Glass, Plastics and Composites.

Books Recommended:

1. A Text Book of Material Sciences and Metallurgy - O. P. Khanna, Dhanpat Rai Publications.
2. Materials Science and Engineering: An Introduction - William D. Calliste, John Wiley & Sons.

RME 4226: Machine Design and System Dynamics - 3 Credit

Machine Design:

Introduction to Design and Stress Analysis, Thick-walled Pressure Vessel, Contact Stresses, Stresses in Curved Members, Shock and Impact, Deflection and Stiffness Consideration, Machines in Design, Mechanical Spring, Design for Fatigue Strength, Fracture Mechanics in Design, Strain Energy, Statistical Consideration, Failure Theories.

System Dynamics:

Dynamics and Vibration of Discrete Systems with More than One Degree of Freedom (dof). Methods for Writing the Equations of Motion of Multi Degree of Freedom. Non-linear Systems and Linearization of the Equation of Motion Around a Steady-state Solution, Free and Forced Motion of A Linear Multi Degree of Freedom System, Effect of Harmonic, Periodic, and Non-periodic Forces. Techniques for Identification of Modal Parameters from Measurements of System's Dynamics Behavior, Modal Superposition Theorem, Continuous and Discrete Systems.

Books Recommended:

1. Shigley's Mechanical Engineering Design - Budynas & Nisbett, McGraw Hill.
2. System Dynamics - Ogata, K., Prentice Hall.
3. System Dynamics - Vu, Hung V, Ramin S. Enfandiari, McGraw-Hill.

RME 4227: Introduction to Nanoscience and Nanotechnology - 3 Credit

Introduction: Importance of Nanotechnology, History of Nanotechnology, Nanoscience vs Nanotechnology, Properties of Nanomaterials, Difference between Bulk and Nanomaterial. Effect of Length Scale, Influence of Nano Structure on Mechanical, Optical, Electronic, Magnetic and Chemical Properties. Overview of Different Nanomaterials Available.

Synthesis and Fabrication of Nanomaterials: Nanomaterials Synthesis, "Top-Down" and "Bottom-Up" Approaches of Nanomaterial (Nanoparticles, Nanoclusters and Quantum Dots) Synthesis. Self-assembly, Self-assembled Monolayers, Directed Assembly, Layer-by-layer Assembly. Pattern Replication Techniques: Soft Lithography, Nanoimprint Lithography.

Different Classes of Nanomaterials: Quantum Dots, Gold, Silver, Different Types of Nano-oxides, Al_2O_3, TiO_2, ZnO etc. Carbon Nanotubes, Preparation Properties and Applications Like Field Emission Displays. Nanocomposite, Nanopolymers, Nanoglasses, Nanoceramics etc.

Characterization of Nanostructures: Characterization of Nanostructures using Field Emission Scanning Electron Microscopy (FESEM), Environmental Scanning Electron Microscopy (ESEM), X-ray Photoelectron Spectroscopy, Auger Electron Spectroscopy etc.

Application of Nanomaterials: Molecular Motors, Energy Storage, Electronic-nano Particles for Molecular Diagnostics, Nano Biosensors, Nanopharmaceuticals, Nanoparticle-Based Drug Delivery, Nanostructures for Tissue Engineering/Regenerative Medicine etc. Handling, Safety and Hazard of Nanomaterials Processing.

Books Recommended:

1. Nanocomposite Science and Technology - Pulikel M. Ajayan, Wiley.
2. Nanolithography and Patterning Techniques in Microelectronics - David G. Bucknall, Wood Head Publishing.
3. Transport in Nanostructures - D.K. Ferry and S.M. Goodmick, Cambridge University Press.
4. Micro and Nanofabrication - Zheng Cui, Springer.
5. Nanotechnology and Nanoelectronics - W.R, Fahrner, Springer.
6. Hand Book of Nano Science, Engineering, and Technology - William A. Goddard, CRC press.
7. Nanomaterials: Risks and Benefits - Igor Linkov and Jeffery Steevens, Springer.

RME 4228: Introduction to Automobile Engineering - 3 Credit

Introduction: Introduction to Road Vehicles, Components of Automobile.

Automotive Engines: Types and Construction, Engine Subsystems. Alternative Fuels and Alternative Types of Engines- CNG and LPG Powered Vehicles, Hybrid and Electrical Vehicles, Fuel Cell Vehicle etc.

Electrical and Electronic Systems: Cranking Motor, Alternator, Lighting, Electronic Control Systems and Indicators. Air-Conditioning System.

Environmental Considerations: Vehicle Emissions, Noise Pollution and Control Strategies. Vehicle Fuel Economy, Testing of Vehicles, Motor Vehicle Regulations.

Vehicle Performance and Dynamics: Linear and Angular Inertia, Braking Effects, Gyroscopic Effects and Reactions, Tractive Effort and Vehicle Vibration. Resistance to Vehicle Motion-Gradient Resistance, Aerodynamic Resistance, Rolling and Frictional Resistance, Development Strategies for Minimum Resistance.

Automotive Transmission Systems and Power Train: Clutch, Gear, Automatic Transmission System, Differential and Final Drives.

Automotive Safety: Brakes, Reduction of Injuries.

Automotive Body: Materials, Vehicle Shape, Chassis, Springs and Suspension Systems, Steering System, Tyre.

Vehicular Automation: EFI Engines, Anti-lock Braking (ABS) system, Cruise Control, Traction Control System (TCS), Electronic Stability Control (ESC), Dynamic Steering Response (DSR).

Books Recommended:

1. Automotive Mechanics – William H. Crouse and Donald L. Anglin, Career Education.
2. Test Automotive Handbook – Bosch GmbHd distributed by SAE.
3. Theory of Ground Vehicles – J. Y. Won, John Wiley Sons.
4. Fundamentals of Vehicle Dynamics – T. D. Gillespi, SAE.
5. Advanced Vehicle Technology – H. Heisler, Edwin Arnold.