UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Mechatronics Engineering

Second Year with effect from AY 2020-21

Third Year with effect from AY 2021-22

Final Year with effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering)of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
Member, Academic Council, RRC in Engineering
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Incorporation and implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C ' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
Member, Academic Council, RRC in Engineering
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Program Structure for Second Year Engineering
Semester III & IV
UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
MTC301	Engineering Mathematics-III	3	--	1	3	--	1	4
MTC302	Data Structures and Algorithms	3		--	3		--	3
MTC303	Engineering Materials and Metallurgy	3	--	--	3	--	--	3
MTC304	Basic Electronics and Digital Circuit Design	3	--	--	3	--	--	3
MTC305	Electrical Circuits and Machines	3	--	--	3	--	--	3
MTL301	Data Structures and Algorithms Laboratory	--	2	--	--	1	--	1
MTL302	Applied Electronics Laboratory-I	--	2	--	--	1	--	1
MTL303	Electrical and Electronics Workshop	--	2	--	--	1	--	1
MTSBL301	CAD – Modelling Laboratory#	--	4	--	--	2	--	2
MTPBL301	Mini Project – 1A	--	4[$]	--	--	2	--	2
Total		**15**	**14**	**1**	**15**	**07**	**1**	**23**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract /Oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test1	Test2	Avg.					
MTC301	Engineering Mathematics-III	20	20	20	80	3	25	--	125
MTC302	Data Structures and Algorithms	20	20	20	80	3	--	--	100
MTC303	Engineering Materials and Metallurgy	20	20	20	80	3	--	--	100
MTC304	Basic Electronics and Digital Circuit Design	20	20	20	80	3	--	--	100
MTC305	Electrical Circuits and	20	20	20	80	3	--	--	100

	Machines								
MTL301	Data Structures and Algorithms Laboratory	--	--	--	--	--	25	25	50
MTL302	Applied Electronics Laboratory-I	--	--	--	--	--	25	25	50
MTL303	Electrical and Electronics Workshop	--	--	--	--	--	25	25	50
MTSBL301	CAD – Modelling Laboratory[#]	--	--	--	--	--	25	25	50
MTPBL301	Mini Project – 1A	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	--	**150**	**125**	**775**

$ indicates work load of Learner (Not Faculty), for Mini Project
#Course common with Mechanical Engineering,
SBL – Skill Based Laboratory
PBL – Project Based Learning

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
MTC401	Engineering Mathematics-IV	3	--	1	3	--	1	4
MTC402	Kinematics of Machinery	3	--	1	3	--	1	4
MTC403	Thermal and Fluid Engineering	3	--	--	3	--	--	3
MTC404	Strength of Materials	3	--	--	3	--	--	3
MTC405	Application of Integrated Circuits	3	--	--	3	--	--	3
MTL401	Applied Electronics Laboratory-II	--	2	--	--	1	--	1
MTL402	Material Testing Laboratory#	--	2	--	--	1	--	1
MTL403	Thermal and Fluid Engineering Lab	--	2			1		1
MTL404	Technical Computing Laboratory	--	2	--	--	1	--	1
MTL405	Machine Shop Practice#	--	4	--	--	2	--	2
MTPBL401	Mini Project – 1B	--	4$	--	--	2	--	2
Total		**15**	**16**	**2**	**15**	**8**	**2**	**25**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract /Oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test1	Test2	Avg.					
MTC401	Applied Mathematics-IV	20	20	20	80	3	25	--	125
MTC402	Kinematics of Machinery	20	20	20	80	3	25	--	125
MTC403	Thermal and Fluid Engineering	20	20	20	80	3	--	--	100
MTC404	Strength of Materials	20	20	20	80	3	--	--	100
MTC405	Application of Integrated Circuits	20	20	20	80	3	--	--	100
MTL401	Applied Electronics Laboratory-II	--	--	--	--	--	25	25	50
MTL402	Material Testing Laboratory#	--	--	--	--	--	25	--	25
MTL403	Thermal and Fluid	--	--	--	--	--	25	25	50

	Engineering Laboratory								
MTL404	Technical Computing Laboratory	--	--	--	--	--	25	--	25
MTL405	Machine Shop Practice#	--	--	--	--	--	50	--	50
MTPBL401	Mini Project – 1B	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	--	**225**	**75**	**800**

$ indicates work load of Learner (Not Faculty), for Mini Project
#Course common with Mechanical Engineering,
SBL – Skill Based Laboratory
PBL – Project Based Learning

Course Code	Course Name	Credits
MTC301	**Engineering Mathematics-III**	**04**

Pre-requisite: Engineering Mathematics-I, Engineering Mathematics-II,

Course Objectives:

1. To familiarize with the Laplace Transform, Inverse Laplace Transform of various functions, its applications.
2. To acquaint with the concept of Fourier Series, its complex form and enhance the problem solving skills.
3. To familiarize with the concept of complex variables, C-R equations with applications.
4. To study the application of the knowledge of matrices and numerical methods in complex engineering problems.

Course Outcomes: Learner will be able to….

1. Apply the concept of Laplace transform to solve the real integrals in engineering problems.
2. Apply the concept of inverse Laplace transform of various functions in engineering problems.
3. Expand the periodic function by using Fourier series for real life problems and complex engineering problems.
4. Find orthogonal trajectories and analytic function by using basic concepts of complex variable theory.
5. Apply Matrix algebra to solve the engineering problems.
6. Solve Partial differential equations by applying numerical solution and analytical methods for one dimensional heat and wave equations.

Module No.	Detailed Contents	Hrs.
01	**Module: Laplace Transform** 1.1 Definition of Laplace transform, Condition of Existence of Laplacetransform, Laplace Transform (L) of Standard Functions like $e^{at}, sin(at), cos(at), sinh(at), cosh(at)$ and t^n , $where\ n \geq 0$. 1.2 Properties of Laplace Transform: Linearity, First Shifting theorem, Second Shifting Theorem, change of scale Property, multiplication by *t*, Division by *t, 1.3. 1.3* Laplace Transform of derivatives and integrals (Properties withoutproof).	**06**
	1.4 Evaluation of integrals by using Laplace Transformation. **Self-learning topics:** Heaviside's Unit Step function, Laplace Transform. OfPeriodic functions, Dirac Delta Function.	
02	**Module: Inverse Laplace Transform** 2.1 Inverse Laplace Transform, Linearity property, use of standard formulae to find inverse Laplace Transform, finding Inverse Laplace transform using derivative 2.2 Partial fractions method & first shift property to find inverse Laplace transform. 2.3 Inverse Laplace transform using Convolution theorem (without proof) **Self-learning Topics:** Applications to solve initial and boundary value problems involving ordinary differential equations.	**06**

03	**Module: Fourier Series:** *3.1* Dirichlet's conditions, Definition of Fourier series and Parseval'sIdentity (without proof) 3.2 Fourier series of periodic function with period 2π and2*l,* Fourier series of even and odd functionsHalf range Sine and Cosine Series. **Self-learning Topics:** Complex form of Fourier Series, orthogonal and orthonormal set of functions, Fourier Transform.	**06**
04	**Module: Complex Variables:** 4.1 Function *f*(z) of complex variable, limit, continuity and differentiability of *f*(z), Analytic function, necessary and sufficient conditions for *f*(z) to be analytic (without proof), 4.2 Cauchy-Riemann equations in Cartesian coordinates (without proof) 4.3 Milne-Thomson method to determine analytic function *f*(z) when real part (u) or Imaginary part (v) or its combination (u+v or u-v) is given. 4.4 Harmonic function, Harmonic conjugate and orthogonal trajectories **Self-learning Topics:** Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations	**06**
05	**Module: Matrices:** 5.1 Characteristic equation, Eigen values and Eigen vectors, Properties ofEigen values and Eigen vectors. (**No theorems/proof**) 5.2 Cayley-Hamilton theorem (without proof): Application to find the inverse of the given square matrix and to determine the given higher degree Polynomialmatrix. 5.3 Functions of squarematrix, Similarity of matrices, Diagonalization of matrices **Self-learning Topics:** Verification of Cayley Hamilton theorem, Minimal polynomial and Derogatory matrix & Quadratic Forms (Congruent transformation & Orthogonal Reduction)	**06**
06	**Module: Numerical methods for PDE** 6.1 Introduction of Partial Differential equations, method of separation of variables, Vibrations of string, Analytical method for one dimensional heatand wave equations. (onlyproblems) 6.2 Crank Nicholsonmethod, Bender Schmidt method	**06**
	Self-learning Topics: Analytical methods of solving two and three dimensional problems.	

Assessment:

Term Work:

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per University pattern for practicals.
2. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
3. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering Mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	05 marks
2.	Class Tutorials on entire syllabus	10 marks
3.	Mini project	10 marks

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Examination: Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

References:

1. Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited,
3. Advanced Engineering Mathematics, R. K. Jain and S.R.K. Iyengar, NarosaPublication
4. Advanced Engineering Mathematics, H.K. Das, S. Chand Publication
5. Higher Engineering Mathematics B.V. Ramana, McGraw HillEducation
6. Complex Variables and Applications, Brown and Churchill, McGraw-Hill Education,
7. Text book of Matrices, Shanti Narayan and P K Mittal, S. ChandPublication
8. Laplace transforms, Murray R. Spiegel, Schaum's Outline Series

Course Code	Course Name	Credits
MTC302	**Data Structures and Algorithms**	**03**

Prerequisite: FEC205 C programming

Objectives:

1. To design and implement various data structures and their operations.
2. To introduce the concept of algorithm and its analysis.
3. To learn various algorithm designing strategies.
4. To introduce the appropriate search method on a given problem
5. To develop application using suitable data structure and algorithms.

Outcomes: Learner will be able to…

1. Implement various operations using linear data structures.
2. Apply concepts of Trees and Graphs to a given problem.
3. Analyse time and space complexity of an algorithm.
4. Apply divide and conquer strategy to solve problems.
5. Apply the concept of Greedy and Dynamic Programming approach to solve problems.
6. Apply the concept of backtracking, branch and bound strategy to solve problems.

Module	Detailed Contents	Hrs.
01	**Introduction :**Introduction to Data Structures, Types of Data Structures : Linear and non-linear data structures **Stack:** Introduction to Stack, Stack as ADT, Operations on stack, Application of Stack **Queues** Introduction to Queue, Queue as ADT, Operations on Queue, Circular Queue. Application of Queue	**06**
02	**Linked List:** Introduction to Linked List, Types of Linked List: Singly Linked list, Doubly list, Circular linked list, Operations on linked list, Linked representation of stack, Linked representation of Queue, Applications of linked list.	**05**
03	**Trees**: Introduction to Trees, Types of Trees: Binary tree, Operations on binary tree, Traversal of binary trees, Binary search tree, Applications of Trees, Heap: Operations on Heap data structure, Heap sort, **Graph:** Graph Terminologies, Graph Representation, Graph traversal techniques: Depth first search (DFS) and Breadth First search(BFS)	**07**
04	**Analysis of Algorithms:** Introduction to Algorithm, Analysis of algorithm and it's characteristics, Time and Space complexity, Asymptotic notations. Analysis of Selection Sort and Insertion Sort **Divide and Conquer:** Introduction, Binary search, Finding the minimum and maximum, Merge sort, Quick sort	**05**
05	**Greedy Method Approach :** General Method, Knapsack problem, Minimum cost spanning tree- Kruskal's algorithm and Prim's algorithm **Dynamic Programming Approach :** General Method 0/1 knapsack Problem	**06**

	Travelling salesman problem	
06	**Backtracking and Branch bound** General Method 8 queen problem(N-queen problem) Graph coloring 15 puzzle problem, Travelling salesman problem. **Uninformed Search Techniques:** DFS, BFS, Uniform cost search, **Informed Search Methods:** Best First Search, A*, IDA*, SMA*	**10**

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.(e.g. Suppose Q.2 has part (a) from module3 then part (b) will be from any module other than module 3)
5. In question paper weightage of each module will be proportional to number of respective lecture hrs as mentioned in thesyllabus.

Text Books:

1. Data structures using C by Tenenbaum, Langsam, Augenstein,Pearson.
2. Data Structures using C, ReemaThareja, Oxford.
3. C and Data structures, Prof.P.S.Deshpande, Prof.O.G.Kakde, Dreamtech Press.
4. Introduction to Data Structure and its Applications Jean-Paul Tremblay, P. G. Sorenson
5. Stauart Russell and Peter Norvig, “Artificial Intellingence: A Modern approach”, 3rd Edition Prentice Hall, New Jersey, 1995. 2)

References:

1. Data Structures Using C & C++, Rajesh K. Shukla, Wiley- India.
2. Computer Algorithms by Ellis Horowitz and SartajSahni, Universities Press.
3. Data Structures and Algorithm Analysis in C,MarkA.Weiss ,Pearson
4. ALGORITHMS Design and Analysis, Bhasin, OXFORD.Elaine Rich and Kelvin Knight, “Artificial Intelligence”, 3 rd Edition Tata McGraw Hill, New Delhi, 1991.

Course Code	Course Name	Credits
MTC303	**Engineering Materials and Metallurgy**	**03**

Prerequisite :FEC103 Engineering Chemistry-I, FEC203 Engineering Chemistry-II

Objectives

1. To prepare the students understand basic engineering materials, their properties & selection and applications.
2. To familiarize the students with various types and causes of failure of components in different engineering applications.
3. To acquaint the students with the new concepts of Nano Science and Technology.
4. To prepare the students acquire basic understanding of advanced materials, their functions and properties for technological applications.

Outcomes: Learner will be able to...

1. Distinguish different types of materials and composites used in manufacturing.
2. Select a material for specific applications
3. Read and interpret Iron-Iron Carbide phase diagram, TTT diagram and CCT diagram.
4. Demonstrate a deeper understanding of materials in engineering applications.

Module	Detailed Contents	Hrs.
01	**1.1 Introduction:** Classification of materials, functional classification and classification based on structure. **1.2 Solidification of Metals:** Formation of solids from liquids of pure metals and alloys. Single crystal and polycrystalline structure. **1.3 Crystal Imperfection:** Definition, classification, Point defects: their formation and effects. Dislocations: Edge and screw dislocations, their significance. Surface defects: Grain boundary, sub-angle grain boundary, stacking fault, and their significance.	**5**
02	**2.1 Ferrous Metals and Alloys:** Classification of Alloys based on phases and phase diagram- Binary alloy phase diagram – Isomorphous, Eutectics type I and II, Peritectic. The Iron-Iron Carbide Phase Diagram. Classification of Plain Carbon Steels and Cast Irons. Effect of alloying elements in steels. TTT diagram & CCT diagram. Annealing, normalizing, tempering, hardening and surface hardening processes. **2.2 Nonferrous Metals and Alloys:** Basics only. Important nonferrous materials like aluminium, copper, nickel, tin, zinc and their alloys, properties and applications. **2.3 Powder Metallurgy:** Powder manufacturing methods; Powder Metallurgy Process. Applications such as oil impregnated Bearings and Cemented Carbides. Limitations of Powder Metallurgy.	**10**
03	**3.1 Ceramics:** Definition, comparative study of structure and properties of Engineering Ceramics with reference to metallic materials. Toughening mechanisms in ceramics. Engineering application of Ceramics. **3.2 Polymers:** Classification of polymers. Thermoplastics, effect of temperature on thermoplastics, mechanical properties of thermoplastics. Thermosetting polymers and elastomers. **3.3Composites**: Definition; Classification; Particle-reinforced composites and fibre-reinforced composites. Rule of mixtures; Sandwich structures. Classification of composites on basis of matrix materials.	**9**

04	**4.1 Fracture:** Definition and types of facture. Brittle fracture and Ductile fracture. Ductility transition. **4.2 Fatigue Failure:** Definition of fatigue and significance of cyclic stress. Mechanism of fatigue. Fatigue testing. Test data presentation. S.N. Curve and its interpretation. Influence of important factors on fatigue. **4.3 Creep:** Definition and significance of creep. Effect of temperature and creep on mechanical behaviour of materials. Creep testing.	**5**
05	**5.1 Electronic Materials:** Band structure of solids. Conductivity of metals and alloys. Semiconductors and superconducting materials. Insulators and dielectric properties. Electrostriction, piezoelectricity and ferroelectricity. **5.2 Photonic Materials:** Refraction, reflection, absorption and transmission. Luminescence, Photoconductivity, Lasers, optical fibres in communications. **5.3 Magnetic Materials:** classification of magnetic materials, Diamagnetic, paramagnetic, ferromagnetic, ferromagnetic and super paramagnetic materials. Metallic and ceramic magnetic materials. Applications of magnetic materials.	**6**
06	**6.1 Nano-structured Materials:** Definition and Introduction to nanotechnology. Unique features of nano-structured materials. Typical applications. **6.2 Modern Engineering Materials**: Smart materials, Shape memory alloys, Chromic materials (Thermo, Photo and Electro), Rheological fluids, Metallic glasses.	**4**

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying20marks.
2. Total 04 questions need tobe solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub- questions of 2 to 5 marks willbe asked.
4. Remaining questions will be mixed in nature.(e.g. Suppose Q.2 has part (a) from module3 then part (b) will be from any module other than module3)
5. In question paper weightage of each module will be proportional to number of respective lecture hrs as mentioned inthe syllabus.

Text Books:

1. Callister's Materials Science and Engineering, 2nd edition by R. Balasubramanium, Wiley India Pvt. Ltd

References:

1. The Science and Engineering of Materials (6 th Edition), by Donald R. Askeland, Pradeep P. Fulay, Wendelin J. Wright, Cengage Learning, Inc., Stanford, USA., (2010)
2. Materials Science and Engineering: An Introduction (8th Edition), by William D. Callister, Jr.Adapted by R. Balasubramaniam. Wiley India (P) Ltd., (2010).
3. Introduction to Physical Metallurgy (2nd Edition), by S H Avner, Tata McGraw Hill (1997).
4. A Text Book of Nanoscience and Nanotechnology, by Pradeep.T, Tata McGraw Hill, New Delhi, (2012).
5. Material Science, by S.L. Kakani, New Age International, (2006).
6. Electronic Properties of Materials (4th Edition), by Rolf.E. Hummel, Springer, New York,(2011).
7. Photonic Crystals: Theory, Applications, and Fabrication, by Dennis W Prather, John Wiley &Sons, Hoboken, (2009).

Course Code	Course Name	Credits
MTC304	**Basic Electronics and Digital Circuit Design**	**03**

Prerequisite: FEC105 Basic Electrical Engineering, FEC102 Engineering Physics-I, FEC202 Engineering Physics-II

Objectives

1. To understand working and performance of electronic devices
2. To understand applications of electronic devices.
3. To teach fundamental principles of digital circuit design.
4. To impart the testing knowledge of digital circuits.

Outcomes: Learner will be able to…

1. Illustrate working of Transistors & its applications.
2. Describe several JFET applications including switch & amplifiers.
3. Describe the number system and operations of logical gates
4. Design combinational digital logic circuits
5. Design Sequential digital logic circuits
6. Describe the testing technologies in digital electronics.

Module	Detailed Contents	Hrs.
01	**BJT:** 1.1 **BJT** operation, BJT Voltages and Currents, BJT amplification, Common Base, Common Emitter and Common Collector Characteristics. 1.2 **Transistor Biasing**: Need of biasing, Voltage divider biasing, Base biasing, 1.3 **Applications**: BJT as a switch, BJT as amplifier	**6**
02	2.1 **Junction Field Effect Transistor JFET: C**onstruction, pinch off voltage, transfer characteristic, trans-conductance. Application: JFET as switch, JFET as amplifier 2.2 **Metal-Oxide Effect Transistor (MOSFET): Working** of MOSFET, Application: MOSFET as switch	**5**
03	**Fundamentals of Digital Design** **3.1 Number System -** Review of Number System, Binary Code, Binary Coded Decimal, Hexadecimal Code, Gray Code and their conversions, 3.2 **Logic Gates**: Basic gates, Universal gates, Sum of products and products of sum, minimization with Karnaugh Map (upto four variables) and realization. 3.3 **Combinational Circuits using basic gates as well as MSI devices**: Half adder, Full adder, Half Subtractor, Full Subtractor, multiplexer, demultiplexer, decoder, Comparator (Multiplexer and demultiplexer gate level upto 4:1).	**10**
04	**Elements of Sequential Logic Design** : 4.1 **Sequential Logic**: Latches and Flip-Flops, Conversion of flip flops (timing considerations and metastability are not expected) 4.2 **Counters**: Asynchronous, Synchronous Counters, Up Down Counters, Mod Counters, Ring Counters, Shift registers, Universal Shift Register.	**8**
05	**Sequential Logic Design:** 5.1 Mealy and Moore Machines, Clocked synchronous state machine analysis, State reduction techniques and state assignment, Clocked synchronous state machine design. (Complex word problems like traffic light controller etc. are not expected)	**7**

	5.2 MSI counters (7490, 74163, 74169) and applications	
06	**Testability:** Fault Models, Stuck at faults, ATPG, Design for Testability, Boundary Scan Logic, JTAG and Built in self test.	**3**
Self-study Topic	**VHDL**: Data types, Structural Modeling using VHDL, attributes, data flow, behavioral, VHDL implementation of basic combinational and sequential Circuits.	**--**

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub- questions of 2 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.(e.g. Suppose Q.2 has part (a) from module3 then part (b) will be from any module other than module 3)
5. In question paper weightage of each module will be proportional to number of respective lecture hrs as mentioned in the syllabus.

Text Books:

1. R. P. Jain, Modern Digital Electronics, Tata McGraw Hill Education, Third Edition 2003
2. Applied Electronics by R. S. Sedha, S. Chand Limited, 2008
3. Prin. Of Electronic Devices & Circuit by B.L. Theraja and R. S. Sedha

References:

1. Donald A. Neamen, Electronic Circuit Analysis and Design, TATA McGraw Hill, 2nd Edition, New Delhi
2. William I. Fletcher, 'An Engineering Approach to Digital Design', PHI.
3. B. Holdsworth and R. C. Woods, 'Digital Logic Design', Newnes, 4 th Edition
4. Morris Mano, Digital Design, Pearson Education, Asia 2002.
5. John F. Wakerley, Digital Design Principles And Practices, third Edition Updated, Pearson Education, Singapore, 2002
6. Anil K. Maini, Digital Electronics, Principles, Devices and Applications, Wiley
7. Stephen Brown and ZvonkoVranesic, Fundamentals of digital logic design with VHDL, McGraw Hill, 2nd Edition
8. Electronic Principles 8th Edition By Albert Malvino and David Bates

Course Code	Course Name	Credits
MTC305	**Electrical Circuits and Machines**	**03**

Prerequisite: FEC105 Basic Electrical Engineering, FEC102 Engineering Physics-I
FEC202 Engineering Physics-II

Objectives

1. Network Synthesis of DC and AC circuits.
2. Understand characteristics of R-L-C networks in time and Frequency domain.
3. Understand constructional features and characteristics of Electrical Machines

Outcomes: Learner will be able to…

1. Analyse and Synthesis of network theorems for DC and AC circuits
2. Find two port circuits parameters
3. Analyse and Synthesis R-L-C circuits in time and Frequency domain
4. Illustrate working and performance characteristics of DC Motors
5. Illustrate working and performance characteristics of three phase Induction Motor
6. Implement systems using low power motors specially designed motors

Module	Detailed Contents	Hrs.
01	**Analysis of DC and AC Circuits** **1.1 Analysis of DC Circuits:** Analysis of DC circuits with dependent sources using generalized loop, node matrix analysis (Simple numerical problems) **1.2 Application of Network Theorems to DC Circuits:** Superposition, Thevenin, Norton, Maximum Power Transfer theorem (Simple numerical problems) **1.3 Steady State Analysis of AC circuits:** Analysis of AC circuits with independent sources using generalized loop, node matrix analysis.	**8**
02	**Two Port Networks** **2.1 Parameters:** Open Circuit, Short Circuit, Transmission and Hybrid parameters,reciprocity and symmetry conditions (Simple Problems) **2.2** T and Pi representations	**6**
03	**Time and Frequency Response Analysis** 3.1 S-domain representation of electrical networks , Transfer function. 3.2 Solution of initial and final condition in RL, RC and RLC networks for AC and DC sources. 3.3 Transient and steady state response to step, ramp and impulse signals	**7**
04	**DC Motors** 4.1 Construction, principle of working, classification, EMF equation, Torque equation, characteristics of DC Motors 4.2 Starters for shunt and series motors 4.3 Speed Control: basic principle and working of different methods	**5**
05	**Three Phase Induction Motor** 5.1 Construction, working principle of squirrel cage induction motor 5.2 Torque speed characteristics, power	**7**

	5.3 Speed control methods 5.4 Starting methods: Classification and working of different methods **Single phase Induction Motors:** 5.5 Construction, working, 5.6 Starting methods, 5.7 Torque-speed characteristics and applications	
06	**Special Types of Motors** Construction, working Principle, Types and applications of 6.1 BLDC Motor 6.2 Reluctance Motor 6.3 Universal Motor 6.4 Stepper Motor 6.5 Servo Motor	**6**
Self-study Topic	Introduction, Basic principle, Construction, E.M.F Equation, Losses in a transformer, Applications of Pulse, Isolation, center tapped transformer	**--**

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub- questions of 2 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.(e.g. Suppose Q.2 has part (a) from module3 then part (b) will be from any module other than module 3)
5. In question paper weightage of each module will be proportional to number of respective lecture hrs as mentioned in thesyllabus.

Text Books:

1. Bimbhra P. S., Electric Machinery, Khanna Publisher,
2. Bimbhra P. S., Generalized Machine Theory, Khanna Publisher,
3. E. G. Janardanan, Special Electrical Machines, PHI
4. W H Hayt, S M Durbin, J E Kemmerly, „Engineering Circuit Analysis", 7th Edition Tata McGraw-Hill Education.
5. M. E. Van Valkenburg, „Network Analysis", 3rd Edition, PHI Learning.
6. D. Roy Choudhury, „Networks and Systems", 2nd Edition, New Age International.

References Books:

1. M. G. Say and E. O. Taylor, Direct current machines, Pitman publication
2. Ashfaq Husain, Electric Machines, Dhanpat Rai and co. publications
3. M. V. Deshpande, Electric Machines, PHI
4. N Balabanian and T.A. Bickart, Linear Network Theory: Analysis, Properties, Design and Synthesis", Matrix Publishers, Inc.
5. C. L.Wadhwa, Network Analysis and synthesis", New Age international.
6. B. Somanathan Nair, "Network Analysis and Synthesis", Elsevier Publications

Course Code	Course Name	Credits
MTL301	**Data Structures and Algorithms Laboratory**	**01**

Objectives:

1. To design and implement various data structures and their operations.
2. To Apply the appropriate search method on a given problem
3. To develop application using suitable data structure and algorithms.

Outcomes: Students will be able to…

1. Implement various operations using linear data structures.
2. Apply concepts of Trees and Graphs to a given problem.
3. Analyze time and space complexity of an algorithm.
4. Apply divide and conquer strategy to solve problems.
5. Apply the concept of Greedy and Dynamic Programming approach to solve problems.
6. Apply the concept of backtracking, branch and bound strategy to solve problems.

Suggested List of laboratory experiments (Minimum Eight):

Experiments to be conducted using C language.Also minimum two experiments from each course outcome shall be covered

Sr. No.	Experiment List
1	Implementation of any one application of stack / Queue/Circular Queue
2	Implementation of operations on Linked Lists
3	Implementation of stack and queue using Link list.
4	Implementation and analysis of selection sort/insertion sort.
5	Implementation of Binary search/ merge sort/quick sort
6	Implementation of operations on Binary Tree/Binary Search Tree/ Heap
7	Implementation Greedy method algorithms Prim's/ Kruskal's algorithm
8	Implementation of Dynamic programming approach algorithms knapsack/Traveling sales persons problem
9	Implementation of Backtracking & branch and bound technique : N queens problem/15 puzzle problem
10	Implementation of any game based on uninformed/informed search algorithms BFS/DFS/A* algorithm Like Maze problems, 4 connect etc

Term Work:

Term work consists of performing minimum 06 practical mentioned as above. Final certification and acceptance of the term work ensures satisfactory performance of laboratory work.
The distribution of marks for term work shall be as follows:

- Laboratory work (Experiment/journal) : 20 marks.
- Attendance (Theory and Practical) : 05Marks

End Semester Examination:

Pair of Internal and External Examiner should conduct Practical and Oral. Practical exam (15 marks) will be on any one of the experiments from the list and oral exam (10 marks) will be based on the entire syllabus of the laboratory.

Course Code	Course Name	Credits
MTL302	**Applied ElectronicsLaboratory-I**	**01**

Objectives

1. To understand performance and characteristics of transistors and Digital Electronics components
2. To study electrical network synthesis
3. To study characterization of different Electrical Machines

Outcomes: Learner will be able to…

1. Implement switching circuits using BJT, MOSFET, JFET
2. Implement different LOGIC circuits
3. Analyse operational characteristics of different Electrical Machines
4. Simulation of Electrical Networks.

Suggested List of laboratory experiments (Minimum 10):

A.List of experiment based on MTC304

1	To find and draw the input output characteristics of BJT in common emitter configuration or BJT as switch.
2	Implementation of BJT/FET as an amplifier
3	To find transfer characteristics of JFET.
4	To find transfer characteristics of MOSFET.
5	Implementation of the truth table of various logic gates.
6	Implementation of NOR Gate & NAND Gate as universal gates.
7	Implementation of full adder circuit using gates.
8	Verification of state tables of RS, JK, T and D flip-flops using NAND & nor gates.
9	Design and implementation of counters using flip-flops using simulation software like QUCS

B.List of experiment based on MTC305

1	Study of different network theorems for DC and AC circuits
2	To find two port network parameters for electrical network
3	Time domain response of R-L-C series circuit: under, over and critically damped. This can be studied by writing a simple programme using any software tool. Plot time domain response and study effect of change in values of R-L-C
4	Write a simple programme for the transfer function of any R-L-C circuit. Plot frequency domain response and study effect of change in values of R-L-C
5	Speed control of DC shunt and series motor
6	Plot torque speed characteristics of DC shunt motor
7	Speed control of three phase/ single phase Induction Motor
8	Characterization of Stepper motor/ Servo Motor/ Reluctance motor.

Term Work:

Term work consists of performing minimum 10 **(5 from Part A& 5 from Part B)** practical mentioned as above. Final certification and acceptance of the term work ensures satisfactory performance of laboratory work.
The distribution of marks for term work shall be as follows:

- Laboratory work Part A (Experiment/journal) : 10 marks.
- Laboratory work Part A (Experiment/journal) : 10 marks
- Attendance (Theory and Practical) : 05Marks
-

End Semester Examination:

Pair of Internal and External Examiner should conduct Practical and Oral. Practical exam (15 marks) will be on any one of the experiments from the list and oral exam (10 marks) will be based on the entire syllabus of the laboratory.

Course Code	Course Name	Credits
MTL303	**Electrical and Electronics Workshop**	**01**

Objectives

1. To introduce the basic laboratory instruments and household electrical & electronic equipments
2. To design PCB and develop small circuits
3. To understand working of different network simulation softwares

Outcomes: Learner will be able to…

1. Understand working of different lab equipment
2. Demonstrate skills in handling electrical components
3. Repair and do maintenance of households appliances.
4. Demonstrate PCB design and soldering skills
5. Understand working of different parts of Computer
6. Simulate Electrical networks using software techniques.

PART A

List of laboratory Work:

Exp No.	Name of the Experiment and content
1	**Study of construction and operation of different lab equipment :** Introduction to different equipment in the lab (multi-meter, CRO, DSO, power supplies, function generators); Resistors, presets, potentiometers, inductors (iron core and ferrite core), capacitors of different ratings.
2	**Introduction to Household electrical wiring** Wiring materials, selection of wire, different switching and protection devices (MCBs/ Fuses/Relays), Cables and cable management Estimation and costing of residential wiring (Simple numerical on wiring of single room), connection of energy meter and distribution board, wiring standards (IS-732, section 4)
3	**Repair of house hold appliances and machines:** Testing, fault finding, Dismantling, assembling and testing after repairs of house hold appliances like fan and regulator, heater, geyser, mixer, washing machine, microwave oven etc
4	**Hardware implementation of Electronics circuits:** Soldering techniques and equipments, PCB Layout (artwork) design using software and Fabrication itching process. Testing and debugging process of assembled circuits. Making small Switching circuits using electronic components.
5	**Study of Computer hardware.** Functional block diagram, unmounting computer CPU, study internal structure of Computer parts.
6	**Introduction to simulating Softwares** Study different simulating softwares like Qucs, Scilab, Matlab. Simulation of small networks using it.
7	**Study of ICT(In circuit Test) and FCT (Function Test) Fixture in electronic mass production.** Test Systems architecture, Automated testing, Types of contact, Bead probe technology , Types of probes, Tip styles, Fixture components, Actuation and hold down mechanisms

Any other experiment based on syllabus which will help students to understand topic/concept.

Books Recommended:

1. J. B. Gupta “Electrical Installation Estimating & costing” S. K. Kataria& Sons, 2009
2. K.B. Raina, S.K. Bhattacharya “Electrical Design Estimating and Costing”, New Age Inter. 2018
3. Alagappan N. &Ekambaram S. Electrical Estimating & costing Tata McGraw hill Ltd.
4. S.L. Uppal and G.C. Garg “Electrical Wiring Estimating and Costing” Khanna Publishers 1987
5. Surjit Singh “Electric Estimating and Costing” DhanpatRai & Co. (P) Limited (2016)
6. K B. Bhatia “Study of Electrical Appliances and Devices” Khanna Publishers
7. John T. Bateson “In Circuit Testing” Springer 2012

PART B

Industrial Visit

One compulsory visit to any Electrical Machines or Electronics Equipments Manufacturing Industry

Term Work: It comprises both part A and B

Term work consists of performing minimum 06 practical as mentioned above. Final certification and acceptance of the term work ensures satisfactory performance of laboratory work.

The distribution of marks for term work shall be as follows:

- Laboratory work (Experiment/journal) : 15 marks.
- Industrial Visit Report : 05 marks.
- Attendance : 05Marks

End Semester Examination:

Pair of Internal and External Examiner should conduct Oral on the entire syllabus of the laboratory.

Course Code	Course Name	Credits
MTSBL301	**Skill Based Lab: CAD – Modeling**	**02**

Prerequisites: Engineering Drawing

Objectives:

1. To impart the 3D modeling skills for development of 3D models of basic engineering components.
2. To introduce Product data exchange among CAD systems.
3. To familiarize with production drawings with important features like GD &T, surface finish, heat treatments etc.

Outcomes: Learner will be able to…

1. Illustrate basic understanding of types of CAD model creation.
2. Visualize and prepare 2D modeling of a given object using modelling software.
3. Build solid model of a given object using 3D modeling software.
4. Visualize and develop the surface model of a given object using modelling software.
5. Generate assembly models of given objects using assembly tools of a modelling software
6. Perform product data exchange among CAD systems.

Sr. No.	Exercises	Hrs.
1	**CAD Introduction** CAD models Creation, Types and uses of models from different perspectives. Parametric modeling.	**2**
2	**2D Modeling** Geometric modeling of an Engineering component, demonstrating skills in sketching commands of creation (line, arc, circle etc.) modification (Trim, move, rotate etc.) and viewing using (Pan, Zoom, Rotate etc.)	**8**
3	**Solid Modeling** 3D Geometric modeling of an Engineering component, demonstrating modeling skills using commands like Extrude, Revolve, Sweep, Blend, Loft etc.	**14**
4	**Surface Modeling** Extrude, Sweep, Trim etc and Mesh of curves, free form surfaces etc. Feature manipulation using Copy, Edit, Pattern, Suppress, History operations etc.	**10**
5	**Assembly** Constraints, Exploded views, interference check. Drafting (Layouts, Standard & Sectional Views, Detailing & Plotting).	**10**
6	**Data Exchange** CAD data exchange formats Like IGES, PDES, PARASOLID, DXF and STL along with their comparison and applicability.	**4**

Assessment:

Term work

Using the above knowledge and skills acquired through six modules students should complete Minimum six assignments/Experiments from the given sets of assignments **(Two from each set)** using standard CAD modeler like PTC Creo/CATIA/ Solid work/UG /any other suitable software.

Set 1: Beginner Level:

3D modeling of basic Engineering components likes Nuts, Bolts, Keys, cotter, Screws, Springs etc.

Set 2: Intermediate Level:

3D modeling of basic Machine components like Clapper block, Single tool post, Lathe and Milling tail stock,Shaper tool head slide, jigs and fixtures Cotter, Knuckle joint, Couplings: simple, muff, flanged Protected flange coupling, Oldham's coupling, Universal coupling,element of engine system and Miscellaneous parts.

Set 3: Advance Level:

1) Generation of any Assembly model (minimum five child parts) along with Production drawing for any of the system by creating 3D modeling with assembly constraints, Interference check, Exploded view, GD&T, Bill of material.

2) Reverse Engineering of a physical model: disassembling of any physical model having not less than five parts, measure the required dimensions of each component, sketch the minimum views required for each component, convert these sketches into 3-D model and create an assembly drawing with actual dimensions

The distribution of marks for Term work shall be as follows:

1. Printouts/Plots : 20 marks
2. Attendance : 05 marks

End Semester Practical/Oral examination:

To be conducted by pair of Internal and External Examiner

1. Practical examination duration is two hours, based on Advance level of the Term work.
   Oral examination should also be conducted to check the knowledge of CAD Modelling Tools.
2. The distribution of marks for practical examination shall be as follows:
   a. Practical Exam ….15 marks
   b. Oral Exam ……10 marks
3. Evaluation of practical examination to be done based on the printout of students work
4. Students work along with evaluation report to be preserved till the next examination

References:

1. Machine Drawing by N.D. Bhatt.
2. A textbook of Machine Drawing byLaxminarayan and M.L.Mathur, Jain brothers Delhi
3. Machine Drawing by Kamat and Rao
4. Machine Drawing by M.B.Shah
5. A text book of Machine Drawing by R.B.Gupta, Satyaprakashan, Tech. Publication
6. Machine Drawing by K.I. Narayana, P. Kannaiah, K.Venkata Reddy
7. Machine Drawing by Sidheshwar and Kanheya
8. Autodesk Inventor 2011 for Engineers and Designers by ShamTickoo and SurinderRaina, Dreamtech Press

Course code	Course Name	Credits
MTPBL301	**Mini Project-1A**	**02**

Objectives:

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcome: Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to lifelong learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book 10
    - Marks awarded by review committee 10
    - Quality of Project report 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing

- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

Course Code	Course Name	Credits
MTC401	**Applied Mathematics-IV**	**04**

Pre-requisite:

Engineering Mathematics-I, Engineering Mathematics-II, Engineering Mathematics-III,

Objectives:

1) To study the concept of Vector calculus & its applications in engineering.
2) To study Line and Contour integrals and expansion of complex valued function in a power series.
3) To familiarize with the concepts of statistics for data analysis.
4) To acquaint with the concepts of probability, random variables with their distributions and expectations.
5) To familiarize with the concepts of probability distributions and sampling theory with its applications.

Outcomes: Learner will be able to….

1) Apply the concept of Vector calculus to evaluate line integrals, surface integrals using Green's theorem, Stoke's theorem & Gauss Divergence theorem.
2) Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals.
3) Apply the concept of Correlation, Regression and curve fitting to the engineering problems in data science.
4) Illustrate understanding of the concepts of probability and expectation for getting the spread of the data and distribution of probabilities.
5) Apply the concept of probability distribution to engineering problems & Testing hypothesis of small samples using sampling theory
6) Apply the concepts of parametric and nonparametric tests for analyzing practical problems.

Module	Detailed Contents	Hrs.
01	**Module : Vector Calculus** Solenoidal and irrotational (conservative) vector fields. Line integrals – definition and problems. Green's theorem (without proof) in a plane, Stokes' theorem (without Proof), Gauss' Divergence theorem (without proof) and problems (only evaluation). **SelfLearningTopics**: Identities connecting Gradient, Divergence and Curl, Angle between surfaces. Verifications of Green's theorem, Stoke's theorem & Gauss-Divergence theorem, related identities & deductions.	**06**
02	**Module: Complex Integration** Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions (without proof), Cauchy's Integral formula (without proof). Taylor's and Laurent's series (without proof). Definition of Singularity, Zeroes, poles of $f(z)$, Residues, Cauchy's Residue Theorem (without proof) **Self-learning Topics:** Application of Residue Theorem to evaluate real integrations.	**06**

03	**Module: Statistical Techniques** Karl Pearson's Coefficient of correlation (r) and related concepts with problems Spearman's Rank correlation coefficient (R) (Repeated& non repeated ranks problems), Lines of regression, Fitting of first and second degree curves. **Self-learning Topics:** Covariance, fitting of exponential curve.	**06**
04	**Module: Probability Theory:** Conditional probability, Total Probability and Baye's Theorem. Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables, Expectation, Variance, Co-variance, moments, Moment generating functions, (Four moments about the origin &about the mean). **Self- learning Topics:** Properties variance and covariance,	**06**
05	**Module: Probability Distribution and Sampling Theory-I** Probability Distribution: Poisson and Normal distribution, Sampling distribution, Test of Hypothesis, Level of Significance, Critical region, One-tailed, and two-tailed test, Degree of freedom. Students't-distribution (Small sample). Test the significance of single sample mean and two independent sample means and paired t-test) **Self -learning Topics: Test** of significance of large samples, Proportion test, Survey based project.	**06**
06	**Module: Sampling theory-II** 6.1 Chi-square test: Test of goodness of fit and independence of attributes (Contingency table) including Yate's Correction. 6.2 Analysis of variance: F-test (significant difference between variances of two samples) **Self- learning Topics:** ANOVA**:** One way classification, Two-way classification (short-cut method).	**06**

Assessment:

Term Work:

General Instructions:

1) Batch wise tutorials are to be conducted. The number of students per batch should be as per University pattern for practical.
2) Students must be encouraged to write at least 6 class tutorials on entire syllabus.
3) A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	05 marks
2.	Class Tutorials on entire syllabus	10 marks
3.	Mini project	10 marks

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Examination: Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

References:

1. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited,
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication, 4. Vector Analysis, Murray R. Spiegel, Schaum Series
4. Complex Variables and Applications, Brown and Churchill, McGrawHillEducation
5. Probability, Statistics and Random Processes, T. Veerarajan, Mc. GrawHillEducation.

Course Code	Course Name	Credits
MTC402	**Kinematics of Machinery**	**04**

Prerequisite: FEC104 Engineering Mechanics

Objectives

1. To acquaint with basic concepts of kinematics and kinetics of machine elements
2. To understand analysis of mechanisms.
3. To understand synthesis of mechanisms.
4. To study functioning of motion and power transmission machine elements

Outcomes: Learner will be able to…

1. Identify various components of mechanisms
2. Conduct displacement, velocity and acceleration analysis of various mechanisms
3. Synthesize mechanisms to provide specific motion
4. Select appropriate power transmission mechanism.
5. Choose a cam profile for the specific follower motion

Module	Detailed Contents	Hrs.
01	**1.1 Kinetics of Rigid Bodies** Concept of mass moment of inertia and its application to standard objects. Kinetics of rigid bodies: Work and energy Kinetic energy in translating motion, Rotation about fixed axis and in general plane motion, Work energy principle and Conservation of energy **Basic Kinematics** Structure, Machine, Mechanism, Kinematic link & its types, Kinematic pairs, Types of constrained motions, Types of Kinematic pairs, Kinematic chains, Types of joints, Degree of freedom (mobility), Kutzbach mobility criterion, Grűbler's criterion & its limitations Four bar chain and its inversions, Grashoff's law, Slider crank chain and its inversions, Double slider crank chain and its inversions	7
02	**2.1 Displacement Analysis of Mechanisms** Forward and inverse kinematics of planer mechanisms (Closed and open chain). **2.2 Velocity Analysis of Mechanisms (mechanisms up to 6 links)** Velocity analysis by instantaneous centre of rotation method (Graphical approach), Velocity analysis by relative velocity method (Graphical approach) **2.3 Acceleration Analysis of Mechanisms (mechanisms up to 6 links)** Acceleration analysis by relative method including pairs involving Coriolis acceleration (Graphical approach)	10
03	**Synthesis of Mechanisms and linkages**: Classification of Synthesis Problem, precision points for function Generation, Graphical synthesis of four bar mechanism, Three position synthesis, Four point synthesis, coupler-curve synthesis, Graphical synthesis of slider crank mechanism, Synthesis of four bar mechanism for body guidance.	5
04	**Belts, Chains and Brakes:** **Belts**: Introduction, Types and all other fundamentals of belting, Dynamic analysis – belt tensions, condition of maximum power transmission	**4**

	Chains (No problems)**:** types of chains, chordal action, variation in velocity ratio, length of chain (No problems) **Brakes** (No problems)**:** Introduction, types and working principles, Introduction to braking of vehicles	
05	**Gears and Gear Trains:** **Gears**- Introduction, Types, Law of gearing, Forms of teeth, Details of gear terminology, Path of contact, Arc of contact, Contact ratio, Interference in involutes gears, Minimum number of teeth for interference free motion, Methods to control interference in involutes gears, **Gear Trains:** Kinematics and dynamic analysis of simple and compound gear trains, reverted gear trains, epi-cycle gear trains with spur or bevel gear combination	**7**
06	**6.1 Straight Line Generating Mechanisms** Exact–Peaucellier , Approximate– Watt, Grasshopper and Tchebicheff's. **6.2 Compliant mechanisms**, Flexure based straight line mechanism. **6.3 Cam and Follower Mechanism** Cam and its Classification based on shape, follower movement, and manner of constraint of follower; Followers and its Classification based on shape, movement, and location of line of movement; Cam and follower terminology; Motions of the follower: SHM, Constant acceleration and deceleration (parabolic), Constant velocity, Cycloidal; Layout of cam profiles.	**6**
Self-study Topic	Offset slider crank mechanisms, Pantograph, Steering Gear Mechanism- Ackerman, Davis steering gears Static force analysis in gears - spur, helical, bevel, worm & worm wheel	**--**

Term Work:

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per University pattern for practicals.
2. Graphical approach problems (minimum 10) from module 2, 3 and 6 should be solved under the guidance of instructor in a A3 size drawing book.
3. Software tools such as **MechAnalyzer® and MotionGenor any other similar software tool** should be used for demonstration and innovative exercises in addition to graphical approach problems.

The distribution of Term Work marks will be as follows
Attendance theory and tutorials 5 marks,
Graphical approach problems 15 marks,
Software exercises 5 marks.

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying20marks.
2. Total 04 questions need tobe solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub- questions of 2 to 5 marks will be asked.

4. Remaining questions will be mixed in nature.(e.g. Suppose Q.2 has part (a) from module3 then part (b) will be from any module other than module3)
5. In question paper weightage of each module will be proportional to number of respective lecture hrs as mentioned in the syllabus.

Text Books:

1. S.S. Ratan, “Theory of Machines”, Tata McGraw Hill
2. A. Ghosh and A.K. Mallik, “Theory of Mechanisms and Machines”, East-West Press

References:

1. J.J. Uicker, G.R. Pennock, and J.E. Shigley, “Theory of Machines and Mechanism”, Oxford Higher Education
2. P.L. Ballaney, “Theory of Machines”, Khanna Publishers
3. M.A. Mostafa, “Mechanics of Machinery”, CRC Press
4. R.L. Norton, “Kinematics and Dynamics of Machinery”, McGraw Hill
5. A.G. Erdman, G.N. Sander, and S. Kota, “Mechanism Design: Analysis and Synthesis Vol I”, Pearson
6. Kinematics of Machines by R T Hinckle (Prentice Hall Inc.)
7. Kinematics By V.M. Fairs (McGraw Hill)
8. Kinematics and Dynamics of Planer Mechanisms by Jeremy Hirsihham (McGraw Hill).

Course Code	Course Name	Credits
MTC403	**Thermal and Fluid Engineering**	**03**

Prerequisite:FEC102 Engineering Physics-I, FEC202 Engineering Physics-II, FEC104 Engineering Mechanics

Objectives

1. Study of basic concepts and laws of thermodynamics.
2. To study the properties of the fluids.
3. To study the transport of mass, momentum and energy.
4. Study of modes of heat transfer and governing laws.
5. Study and analysis of Boilers, turbines and heat exchangers

Outcomes: Learner will be able to…

1. Demonstrate understanding of basic concepts of thermodynamics.
2. Illustrate the physical properties and characteristic behavior of fluids.
3. Illustrate dimensional analysis for model and similitudes.
4. Identify & explain the three modes of heat transfer (conduction, convection and radiation) with mathematical model
5. Design and analyze different heat exchangers
6. Demonstrate basic understanding of turbines and IC engines.

Module	Detailed Contents	Hrs.
01	**Thermodynamics:** Systems and control volumes, Properties of system, Continuum, State and equilibrium, Processes and cycles, Temperature and Zeroth law of thermodynamics, Heat and thermodynamic concept of work. The first & second laws of thermodynamics. Thermal energy reservoirs, concept of heat engine, refrigerator, heat pump and perpetual motion machines. Concept of entropy, Principle of Increase of entropy.	6
02	**Fluid Mechanics I:** Properties of fluids – Specific gravity, specific weight, viscosity, compressibility, vapour pressure and gas laws – capillarity and surface tension. Continuum models, characteristics of fluids. Fluid Statics, hydrostatic pressure, forces on submerged surfaces. Buoyancy and stability of floating bodies. Flow Kinematics, Types of flow, Flow field, velocity, acceleration, stream function, vorticity. Incompressible inviscid flow, Euler's and Bernoulli's equation. Flow in conduits and pipes	6
03	**Fluid Mechanics II:** Incompressible viscous flow, fully developed flow in pipes, head loss, major and minor losses, Flow measurement, pipeline networks. Boundary layers and flow over objects. Introduction to Compressible Flow - speed of sound, stagnation properties, Steady state-one-dimensional compressible flow - basic equations for isentropic flow, adiabatic flow with friction. Dimensional analysis and similitude.	8
04	**Heat Transfer I:**Introduction, Conduction: Fourier's Law, One dimensional heat transfer with and without heat generation, Transient conduction, Through Composite walls. Extended Surfaces: Heat transfer from finned surfaces, Fin Efficiency, Effectiveness.	6

05	**Heat Transfer II :**Convection: Free and forced convection, Flow and thermal boundary layer equations, laminar flow through circular pipe, constant heat flux and constant wall temperature conditions, Overall heat transfer coefficient. Heat exchangers, Thermal Radiation: Radiation properties, Plank's Law, Kirchoff's law, Heat exchange between, two surfaces.	7
06	**Thermo-fluid Machines:** Steam boilers and their classification, Mountings and accessories, Layout of a modern HP boiler, Boiler performance, Boiler efficiency Properties of steam like dryness fraction; enthalpy; internal energy and entropy, Steam table and Mollier Diagram, Steam turbines, Impulse turbines, Reaction turbines, velocity diagram, degree of reaction, compounding of steam turbines, IC engines, Air standard cycles, Carnot, Otto, diesel, dual cycles and their comparison, Two stroke and Four stroke engines, CI and SI engines.	6
Self-study Topic	Hydro turbines: Pelton wheel, Francis turbine and Kaplan turbine. Gas Turbines Ideal and actual Brayton cycle.	**--**

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub- questions of 2 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.(e.g. Suppose Q.2 has part (a) from module3 then part (b) will be from any module other than module 3)
5. In question paper weightage of each module will be proportional to number of respective lecture hrs as mentioned in thesyllabus.

Text Books:

1. Frank M. White, "Fluid Mechanics", MGH
2. Fox and McDonald, "Introduction to Fluid Mechanics", Wiley
3. F. P. Incropera and D.P. Dewitt, "Fundamentals of Heat and Mass Transfer", Wiley
4. M. N. Ozisik, "Heat Transfer: A Basic Approach", MGH

References:

1. Introduction to Thermodynamics and Heat Transfer, YunusCengel, 2 nded, McGraw-Hill
2. Fundamentals of Thermodynamics, Sonntag, Borgnakke, Van Wylen, Wiley India Pvt. Ltd.
3. Applied Thermodynamics, Onkar Singh, 3 rded, New Age International
4. Basic Engineering Thermodynamics, Rayner Joel, Longman Publishers
5. Basic Engineering Thermodynamics, Zemanski and Van ness, TMH

Course Code	Course Name	Credits
MTC404	**Strength of Materials**	**03**

Prerequisite: FEC104 Engineering Mechanics, MTC303 Engineering Materials and Metallurgy

Objectives:

1. To understand the nature of stresses developed in simple geometries such as bars, cantilevers, beams, shafts, cylinders and spheres subjected to various types of simple loads.
2. To calculate the elastic deformation occurring in various simple geometries for different types of Loading.
3. To study distribution of various stresses in the mechanical elements under different types of loads.

Outcomes: Learner will be able to…

1. Demonstrate fundamental knowledge about various types of loading and stresses induced.
2. Draw the SFD and BMD for different types of loads and support conditions.
3. Analyse the bending and shear stresses induced in beam.
4. Analyse the deflection in beams and stresses in shaft.
5. Analyse the stresses and deflection in beams and Estimate the strain energy in mechanical elements.
6. Analyse buckling phenomenon in columns.

Module	Detailed Contents	Hrs.
1.	**Moment of Inertia:** Mass Moment of Inertia , Area Moment of Inertia, Parallel Axis theorem, Polar Moment of Inertia, Principal axes, Principal moment of inertia. **Introduction-Concept of Stress** Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses, Stress Strain Diagram, elastic constants and their relations- volumetric, linear and shear strains. Composite sections, Thermal stress and strain. Principal stresses and Principal planes- Mohr's circle. Moment of inertia about an axis and polar moment of inertia	8
2.	**Shear Force and Bending Moment in Beams:** Introduction to types of beams, supports and loadings. Definition of bending moment and shear force, Sign conventions, relationship between load intensity, bending moment and shear force. Shear force and bending moment diagrams for statically determinate beams subjected to points load, uniformly distributed loads, uniformly varying loads, couple and their combinations.	6
3.	**Stresses in Beams:** Theory of bending of beams, bending stress distribution, shear stress distribution for point and distributed loads in simply supported and over-hanging beams, cantilevers.	8

4.	**Deflection of Beams:** Deflection of a beam: Double integration method, Maxwell's reciprocal theorems for computation of slopes and deflection in beams for point and distributed loads. **Torsion:** Stresses in solid and hollow circular shafts.	6
5.	**Thin Cylindrical and Spherical Shells:** Stresses and deformation in Thin Cylindrical and Spherical Shells subjected to internal pressure **Strain Energy:** Strain energy stored in the member due to gradual, sudden and impact loads, Strain energy due to bending and torsion.	6
6.	**Columns:** Buckling load, Types of end conditions for column, Euler's column theory and its limitations and Rankine formula.	5

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.(e.g. Suppose Q.2 has part (a) from module3 then part (b) will be from any module other than module 3)
5. In question paper weightage of each module will be proportional to number of respective lecture hrs as mentioned in thesyllabus.

References:

1. Strength of Materials by Ryder, Macmillan
2. Mechanics of Materials by James M. Gere and Barry J. Goodno, Cengage Learning, 6thEd, 2009
3. Mechanics of Materials by Gere and Timoshenko, CBS 2nd Edition
4. Elements of Strength of Materials by Timoshenko and Youngs, Affiliated East –West Press
5. Mechanics of Materials byBeer, Jhonston, DEwolf and Mazurek, TMHPvt Ltd., New Delhi
6. Mechanics of Structures by S.B.Junnarkar, Charotar Publication
7. Mechanics of Materials by S.S.Ratan, Tata McGraw Hill Pvt. Ltd
8. Introduction to Solid Mechanics by Shames, PHIStrength of Materials by S. Ramamrutham, Dhanpat Rai Pvt. Ltd
9. Strength of Materials by W.Nash, Schaum's Outline Series, McGraw Hill Publication, Special Indian Edition
10. Strength of Materials by R. Subramanian, Oxford University Press, Third Edition 2016

Course Code	Course Name	Credits
MTC405	**Application of Integrated Circuits**	**03**

Prerequisite: MTC304Basic Electronics and Digital Circuit Design, MTC305 Electrical Circuits and Machines

Objectives:
1. To teach fundamental principles of standard linear integrated circuits.
2. To develop a overall approach for students from selection of integrated circuit, study its specification, the functionality, design and practical applications

Outcomes: Learner will be able to..
1. Demonstrate an understanding of fundamentals of integrated circuits.
2. Analyze the various applications and circuits based on particular linear integrated circuit.
3. Select and use an appropriate integrated circuit to build a given application.
4. Design an application with the use of integrated circuit

Module	Detailed Contents	Hrs.
01	**Fundamentals of Operational Amplifier** 1.1 Ideal Op Amp, characteristics of op-amp, op-amp parameters, high frequency effects on op-amp gain and phase, single supply versus dual supply op-amp 1.2 Operational amplifier open loop and closed loop configurations, Inverting and non-inverting amplifier	6
02	**Linear Applications of Operational Amplifier** **2.1 Amplifiers**: Adder, subtractor, integrator, differentiator, current amplifier, difference amplifier, instrumentation amplifier and application of Op-Amp **2.2 Converters:** Current to voltage converters, voltage to current converters **2.3 Active Filters:** First order filters, low pass, high pass, band pass and band reject filters. **2.3 Sine Wave Oscillators:** RC phase shift oscillator and Wien bridge oscillator.	9
03	**Non-Linear Applications of Operational Amplifier** **3.1 Comparators:** Inverting comparator, non-inverting comparator, zero crossing detector, window detector and level detector. **3.2 Schmitt Triggers**: Inverting and non-inverting Schmitt trigger **3.3 Waveform Generators:** Square wave generator and triangular wave generator with duty cycle modulation **3.4 Precision Rectifiers:** Half wave and full wave precision rectifiers and their applications. **3.5 Peak Detectors**, Sample & Hold Circuits, voltage to frequency converter, frequency to voltage converter, logarithmic converters and antilog converters	8
04	**Data Converters** **4.1 Analog to Digital:** Performance parameters of ADC, Single Ramp ADC, ADC using DAC, Dual Slope ADC, Successive Approximation ADC, Flash ADC. **4.2 Digital to Analog:** Performance parameters of DAC, Binary weighted register DAC, R/2R ladder DAC, Inverted R/2R ladder DAC	5
05	**Special Purpose Integrated Circuits** 5.1 Functional block diagram, working, design and applications of Timer 555. 5.2 Functional block diagram, working and applications of VCO 566, XR 2206, power amplifier LM380.	5

06	**Voltage Regulators** 6.1 Functional block diagram, working and design of three terminal fixed (78XX, 79XX series) and three terminal adjustable (LM 317, LM 337) voltage regulators. 6.2 Functional block diagram, working and design of general purpose 723 (LVLC, LVHC, HVLC and HVHC) with current limit and current fold-back protection, Switching regulator topologies	6

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub- questions of 2 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.(e.g. Suppose Q.2 has part (a) from module3 then part (b) will be from any module other than module 3)
5. In question paper weightage of each module will be proportional to number of respective lecture hrs as mentioned in the syllabus.

Text Book

Ramakant A. Gayakwad, "Op-Amps and Linear Integrated Circuits", Pearson Prentice Hall, 4th Edition.

References:

1. Sergio Franco, "Design with operational amplifiers and analog integrated circuits", Tata McGraw Hill, 3rd Edition.
2. William D. Stanley, "Operational Amplifiers with Linear Integrated Circuits ", Pearson, 4th Edition
3. D. Roy Choudhury and S. B. Jain, "Linear Integrated Circuits", New Age International Publishers, 4th Edition.
4. David A. Bell, "Operation Amplifiers and Linear Integrated Circuits", Oxford University Press, Indian Edition.
5. R. P. Jain, "Modern Digital Electronics," Tata McGraw Hill, 3rd Edition.
6. Ron Mancini, "Op Amps for Everyone", Newnes, 2nd Edition.
7. J. Millman and A. Grabel, "Microelectronics", Tata McGraw Hill, 2nd Edition.
8. R. F. Coughlin and F. F. Driscoll, "Operation Amplifiers and Linear Integrated Circuits", Prentice Hall, 6th Edition.
9. J. G. Graeme, G. E. Tobey and L. P. Huelsman, "Operational Amplifiers- Design & Applications", NewYork: McGraw-Hill, Burr-Brown Research Corporation.

Course Code	Course Name	Credits

MTL401	Applied Electronics Laboratory-II	01

Objectives:

1. Study of electronic amplifier
2. Study of interfacing
3. Time domain analysis of systems

Outcomes: Learner will be able to...

1. Characterize op-amp
2. Design and test of various op amp circuits.
3. Do time domain characterization of system.

List of Experiments:

1	Experiment on op amp parameters
2	Experiment on design of application using op amp like amplifiers, integrator, differentiators, and active filters
3	Experiment on implementation of op amp application e.g. oscillator
4	Experiment on Voltage comparator and zero crossing detectors
5	Experiment to determine capture range; lock in range and free running frequency of PLL
6	Experiment on Astable and monostablemultivibrator using timer IC 555.
7	Experiment on Voltage Regulator
8	Simulation experiment based on time domain analysis of continuous time systems
9	Simulation experiment on Laplace/z-Transform
10	Simulation experiment on CTFT and DTFT

Term Work:

Term work consists of performing minimum 08 practical mentioned as above. Final certification and acceptance of the term work ensures satisfactory performance of laboratory work.
The distribution of marks for term work shall be as follows:

- Laboratory work (Experiment/journal : 20 marks
- Attendance: 05Marks

End Semester Examination:

Pair of Internal and External Examiner should conduct Practical &Oral examination based on entire syllabus.

Practical Performance: 15 Marks
Oral: 10 Marks

Course Code	Course Name	Credits
MTL402	**Material Testing Laboratory**	**01**

Objectives:
1. To know the use of metallurgical microscope for study of metals
2. To understand the microstructures of ferrous (steel and cast iron) metals
3. To get exposure of material testing by performing experiment related to Hardness , Fatigue, Tension, Torsion, Impact and Flexural Test

Outcomes: Learner will be able to…
1. Understand the procedure used to prepare metallic samples for studying its microstructure
2. Identify effects of heat treatment on microstructure of medium carbon steel and hardenability of steel using Jominy end Quench test
3. Perform Fatigue Test and draw S-N curve
4. Perform Tension test to analyse the stress - strain behaviour of materials
5. Measure torsional strength, hardness and impact resistanceof the material
6. Perform flexural test with central and three point loading conditions

a) List of Experiments: Total eight experiments are required to be performed. Four Experiments from each group

Experiment Number	Detailed Contents		Laboratory Sessions
	Group A		
11.	Study of Characterization techniques and Metallographic sample preparation and etching		2 Hrs
12.	Comparison of Microstructures and hardness before and after Annealing, Normalizing and Hardening in medium carbon steel	**Any two**	2 Hrs
13.	Study of tempering characteristics of hardened steel		
14.	Determination of hardenability of steel using Jominy end Quench Test (Using different hardness testers to measure the Hardness)		
15.	Fatigue test – to determine number of cycles to failure of a given material at a given stress		2 Hrs
	Group B		
16.	Tension test on mild steel bar (stress-strain behaviour, determination of yield strength and modulus of elasticity)		2 Hrs
17.	Torsion test on mild steel bar / cast iron bar		2 Hrs
18.	Impact test on metal specimen (Izod/Charpy Impact test)		2 Hrs
19.	Hardness test on metals – (Brinell/ Rockwell Hardness Number		2 Hrs
20.	Flexural test on beam (central loading)		2 Hrs

b) Assignments: At least one problem on each of the following topics:
1. Simple stress strain
2. SFD and BMD
3. Stresses in beams
4. Torsion and deflection.
5. Thin cylinder and strain energy
6. Buckling of Columns

Note: Preferably, the assignments shall be based on live problems. **Project Based Learning may be Incorporated by judiciously reducing number of assignments.**

Assessment:

Term Work: Including Part a and b both
Distribution of marks for Term Work shall be as follows:

Part a: 15 Marks.
Part b: 05 Marks
Attendance: 05 marks.

End Semester Practical/Oral Examination:
Pair of Internal and External Examiner should conduct practical examination followed by Oral

Course Code	Course Name	Credits
MTL403	**Thermal and Fluid Engineering Lab**	**01**

Objectives

1. Verify the Bernoulli's principle.
2. To familiarize concept of pipe flow.
3. To familiarize concept of thermal conductivity, heat transfer coefficient.
4. To familiarize heat balance in heat exchanger.

Outcomes: Learner will be able to…

1. Verify the Bernoulli's principle and calibration venturimeter / orificemeter.
2. Calculate friction factor & different losses in the pipe flow
3. Estimate thermal conductivity of metals/non-metals.
4. Compute heat transfer coefficient in natural as well forced convection

Part A: Suggested List of laboratory experiments (Minimum 8):

1. Verification of the Bernoulli's theorem.
2. Determination coefficient of discharge for venturimeter / orificemeter
3. Determine the friction factor for Pipes.
4. Determination of minor losses in Pipe systems.
5. Comparison of thermal conductivity of a metal rod and insulating material.
6. Comparison of heat transfer coefficient of free and forced convection.
7. Verification of Stefan Boltzmann Law.
8. Estimation of overall heat transfer coefficient and effectiveness of double pipe heat exchanger (parallel flow and Counter flow arrangement)
9. Study of Boiler cross section
10. Study of Pelton Turbine

Part B: Industrial visit at any type of Power Plant

Term Work:

Term work consists of performing minimum 08 practical mentioned as above. Final certification and acceptance of the term work ensures satisfactory performance of laboratory work.

The distribution of marks for term work shall be as follows:

- Laboratory work (Experiment/journal) : 15 marks.
- Industrial Visit Report : 05 marks.
- Attendance (Theory and Practical) : 05Marks

End Semester Examination:

Pair of Internal and External Examiner should conduct Oral examination based on entire syllabus.

Course Code	Course Name	Credits
MTL404	**Technical Computing Laboratory**	**01**

Objectives

1. Understand and apply tools available for technical computing
2. Understand data manipulation and visualization
3. Programming for engineering applications

Outcomes: Learner will be able to…

2. Import , manipulate and graphically represent data.
3. Perform basic engineering calculations using automated tools.
4. Apply programming for modelling engineering systems.
5. Manipulate and visualize complex data.

Suggested List of laboratory experiments:

1	Importing data , sorting, filtering, formula, logical functions, statistical functions charts, graph plotting , curve fitting, using Microsoft Office Excel (or similar sheet based application)
2	Create an excel sheet for automatically solving heat transfer/strength of material problem using formula.
3	MATLAB® /Scilab data import , matrix manipulation and visualization, plotting , Surface Plots , histogram etc.
4	MATLAB® /Scilab programming , branching , loops and functions related exercise
5	Flat plate Cam profile modelling (Angle as input follower displacement as output) using MATLAB® /Scilab
6	Simulink /xcosintroduction ,commonly used blocks, Transfer function, Modelling and simulation of dynamic system such as Mechanical accelerometer.
7	Electrical system modelling using MATLAB® or Scilab (RLC Ckt / DC Motor etc)
8	Hydraulic / Thermal system modelling using MATLAB® /Scilab
9	3D Data Visualization (Slicing, Histogram etc) using ParaView or other visualization application
10	3D Data Visualization (Volume, Volume and Surface Combination etc) using ParaView or other visualization application

Term Work:

Term work consists of performing minimum 08 experiments from the list mentioned above. Final certification and acceptance of the term work ensures satisfactory performance of laboratory work. The distribution of marks for term work shall be as follows:

- Laboratorywork (Experiment/journal) : 20marks.
- Attendance (Practical) : 05Marks

References

1) Experiments with MATLAB Cleve Moler October 4, 2011 Mathworks
2) Introduction to Simulink® with Engineering Applications Second Edition Steven T. Karris Orchard Publications
3) The ParaView Tutorial Version 5.6 Kenneth Moreland Sandia National Laboratories

Course Code	Course Name	Credits
MTL405	**Machine Shop Practice**	**02**

Objectives:

1. To familiarize with basic machining processes.
2. To familiarize various machining operations and machine protocols

Outcomes: Learner will be able to…

1. Know the specifications, controls and safety measures related to machines and machining operations.
2. Use the machines for making various engineering jobs.
3. Perform various machining operations
4. Perform Tool Grinding
5. Perform welding operations

Module	Details	Hrs
1	One composite job consisting minimum four parts employing operations performed of various machine tools.	**40**
2	Tool Grinding – To know basic tool Nomenclature	**4**
3	One Job on Welding – Application of Metal Arc Welding	**4**

Assessment:

Term Work:

1. **Composite job** mentioned above and the **Welding Job**
2. Complete Work-Shop Book giving details of drawing of the job and timesheet

The distribution of marks for Term work shall be as follows:
Job Work with complete workshop book ……. 40 marks
Attendance ……. 10 marks

Course Code	Course Name	Credits
MTPBL401	**Mini Project –1B**	**02**

Objectives:

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcome: Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to lifelong learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the

students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.

- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book 10
    - Marks awarded by review committee 10
    - Quality of Project report 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing

- Two reviews will be conducted for continuous assessment,

- First shall be for finalisation of problem and proposed solution
- Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication