Course Curriculum

For

B. Tech. (Mechanical Engineering)

Department of Mechanical Engineering

National Institute of Technology Delhi

w.e.f. the Academic Year

2022-2023

Vision and Mission of the Institute
National Institute of Technology Delhi

VISION

Committed to holistic development of Lives and Society by imparting Knowledge of Science and Technology and Crystallizing the future.

MISSION

Application of Knowledge through learning and inculcating Research Oriented mindset towards Design and Innovative Development for Realistic Societal Solutions.

Department of Mechanical Engineering
National Institute of Technology Delhi

1.1 About the Department

Welcome to the Department of Mechanical Engineering at NIT Delhi. Mechanical Engineering is a diverse field, which involves design, analysis and manufacturing from small machine parts and devices to large systems. We aspire to have a distinguished tradition of excellence in the theme areas ranging from thermal, mechanics, design and manufacturing to CAD/CAM/CAE. Department is committed to disseminate the advanced engineering education and pursues success in research as well. Department is dedicated to preparing students to face the emerging challenges facing by society. The department currently runs one undergraduate program B. Tech. (Mechanical Engineering) and one master's program M. Tech. (CAD/CAM). Ph. D. program is also offered by the Department in all area of the Mechanical Engineering since Academic year 2016-2017. The Department is currently equipped with CAD Laboratory. Intake for M. Tech. CAD/CAM program is 34 seats + 2 seats (through DASA) including GATE scholarship, self-financed & sponsored seats. The program has been started from academic session 2016-17.

The Department's dream is to translate its research and to develop teaching methods so that the underprivileged minds can find technological solutions to future challenges. Students also have the opportunity to work with professionals from various fields in emerging areas such as Internet of Things (IoT), Machine Learning (ML), Smart Healthcare, and Artificial Intelligence (AI), Digital Manufacturing, Mechatronics etc. Currently, Department of Mechanical Engineering has four (04) regular faculties with few faculties expected to join this year. Faculty members of the department have excellent academic & research credentials and published numerous peer reviewed journal articles/ papers, Books, Book Chapters etc. in diversified field and having adequate experience in advanced research. The Department believes that by developing a culture of seeking for knowledge and dissemination of research findings, intellectually sound, self-motivated and reliant mechanical engineers and researchers, who will be the bedrock of our nation's match towards qualitative and massive technological development and dynamic industrialization, will be actualized. In other words, the department hopes to achieve the national goals and objectives of industrialization and self-reliance. As a result, it hopes to produce graduates with strong academic and practical background so that they can fit into the industry immediately upon graduation.

1.2 Vision

To be a global knowledge hub in mechanical engineering education, research, entrepreneurship and industry outreach services.

1.3 Mission

- Impart quality education and training to nurture globally competitive mechanical engineers.
- Provide vital state-of-the-art research facilities to create, interpret, apply and disseminate knowledge.
- Develop linkages with world class educational institutions and R&D organizations for excellence in teaching, research and consultancy services.

B. Tech. (Mechanical Engineering)

2.1 Preamble

B. Tech. (Mechanical Engineering) program offered at NIT Delhi is designed to equip students with a unique blend of skill sets that include:

- Strong theoretical foundation
- Predominantly practice-oriented approach with access to well-equipped and specialized laboratories, and supervised internship via the Practice School
- Hands-on technical training
- Life skills orientation
- Hard and soft skills
- Business perspective, along with emphasis on innovation and entrepreneurship
- Specialized courses in advanced areas such as Robotics, Mechatronics, Biomechanics, etc.

2.2 Salient Features:

- Minimum Credits requirements for completion of BTech program is 160.
- The Curriculum is based on the guidelines of National Education Policy (NEP) – 2020.
- The curriculum has embedded the Multi Exit/ Multi Entry in the BTech program.
- There is provision of Major degree and Minor Degree for students.
- The curriculum is designed to meet the prevailing and ongoing industrial requirements.
- The curriculum includes Project based Education with Projects every year.
- The curriculum is flexible and offers Choice Based Credit System (CBCS).
- The curriculum inherits the Value based Education and offers Interdisciplinary/ Multidisciplinary Courses.
- The Curriculum offers Digital Pedagogy & Flipped Learning with adequate motivation for Entrepreneurship/ Startups.
- The curriculum aims the Holistic Development of the students.

2.3 Cardinal Mentions:

- ✓ Students exiting after completing 1st Year, 2nd Year and 3rd Year will be awarded Certificate, Diploma and Advanced Diploma in Mechanical Engineering respectively. A minimum Credit requirement for Certificate is 40 Credits, Diploma is 80 Credits and Advanced Diploma is 120 Credits respectively.

- ✓ The students can opt for Minor Degree across any specialization offered in the Institute from 5th Semester e.g. a student pursuing B. Tech. (Mechanical Engineering) may opt for Minor Degrees like Artificial Intelligence, Machine Learning, Data Sciences, Communication, VLSI etc. offered by the different Departments in the Institute depending upon his/her interest.

- ✓ The students opting for Minor Degree will have to earn addition credits for the Minor Degree as per Institute norms which may vary from time to time.

Program Educational Objectives (PEOs)

PEO-1	Analyze the complex systems with the help of design engineering, thermal engineering, manufacturing and allied engineering concepts by applying mathematics and sciences.
PEO-2	Demonstrate multi-disciplinary knowledge and skills to analyze, interpret and create solutions to real-life mechanical engineering problems.
PEO-3	Embrace capability to expand horizons beyond engineering for creativity, innovation and entrepreneurship.
PEO-4	Imbibe competence and ethics for social and environmental sustainability with a focus on the welfare of humankind.

Program Outcomes (POs) of B. Tech (Mechanical Engineering)

PO-1	**Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO-2	**Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO-3	**Design/Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
PO-4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO-5	**Modern Tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO-6	**The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO-7	**Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO-8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO-9	**Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO-10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO-11	**Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO-12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

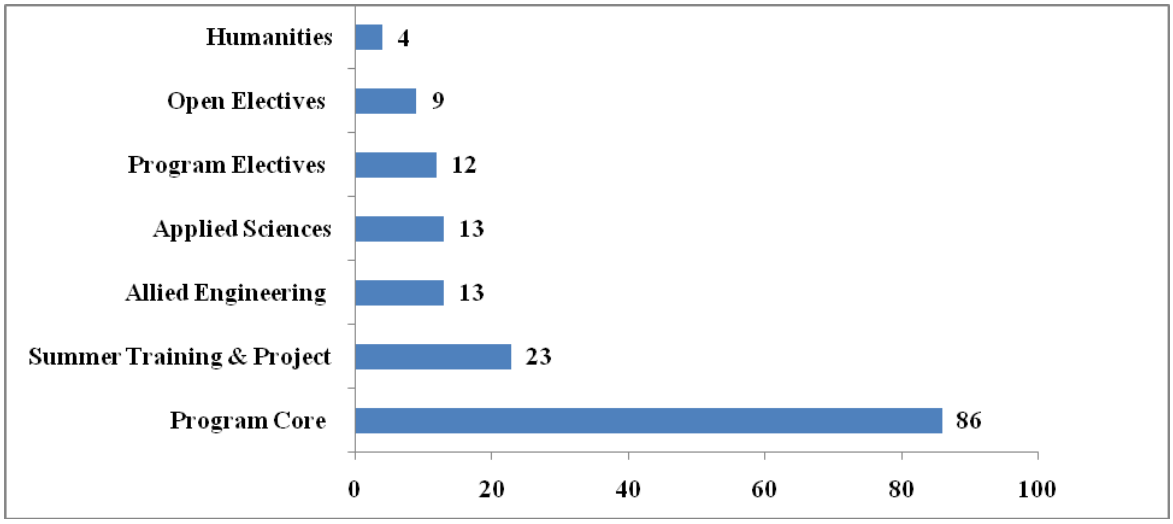
Program Specific Objectives (PSOs)

PSO-1	Students will be able to analyze, interpret and provide solutions to the advanced software tools for design real life mechanical engineering problems.
PSO-2	Students will gain team spirit for working in variety industries like 3-D printing, Additive Manufacturing, HVAC, Aviation, and Automobile & Power Sectors.
PSO-3	Students will be able to pursue higher studies for contribution to research and development as well as participate in Entrepreneurs.

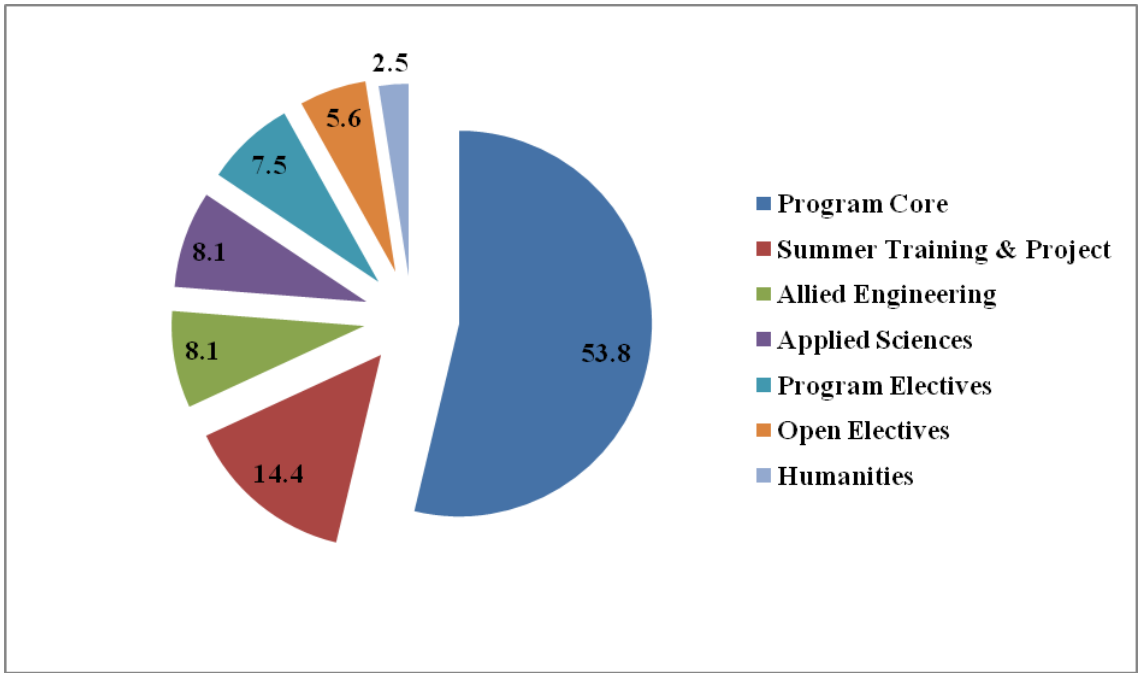
Course and Semester wise Credits

Sl. No.	**Courses**	**Credits**								**Total**
		1st Year		**2nd Year**		**3rd Year**		**4th Year**		
		1st Sem	**2nd Sem**	**3rd Sem**	**4th Sem**	**5th Sem**	**6th Sem**	**7th Sem**	**8th Sem**	
1	Program Core	7	11	16	18	16	15	3	0	86
2	Program Electives						3	6	3	12
3	Open Electives							6	3	9
4	Applied Sciences	8	2	3						13
5	Humanities	2	1					1		4
6	Summer Training & Project		2	1	2	1	2	1	14	23
7	Allied Engineering	3	4			3		3		13
Total		**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**160**

I. Credits Distribution among Different Courses Categories



II. Percentage (%) Credit Distribution among Different Courses Categories



4.1 Course Scheme

SEMESTER – I

Sl. No.	Course Code	Course Name	Credits		L	T	P	C
1	MALB 101	Engineering Mathematics-I	3	3	3	0	0	3
2	PHBB 111	Engineering Physics	3+1	4	3	0	2	4
3	MEBB 111	Introduction to Manufacturing Technology	3+1	4	3	0	2	4
4	HMLB 101	Communication Skills	2	2	2	0	0	2
5	CSBB 111	Computer Programming	2+1	3	2	0	2	3
6	MELB 101	Introduction to Sensors, Actuators & IoT	2	2	2	0	0	2
7	MEPB 122	Joy of Engineering	1	1	0	0	2	1
8	HSPB 150	Holistic Health & Sports	1	1	0	0	2	1
	Total		**15+5**	**20**	**15**	**0**	**10**	**20**

SEMESTER – II

Sl. No.	Course Code	Course Name	Credits		L	T	P	C
1	MEBB 161	Engineering Materials	3+1	4	3	0	2	4
2	MELB 151	Engineering Mechanics	3	3	3	0	0	3
3	MEBB 162	Engineering Visualization	3+1	4	3	0	2	4
4	EEBB 161	Introduction to Electrical & Electronics Engineering	3+1	4	3	0	2	4
5	CELB 101	Environmental Sciences	2	2	2	0	0	2
6	HMPB 171	Technical Report Writing	1	1	0	0	2	1
7	MEPB 171	Project-I	2	2	0	0	0	2
	Total		**14+6**	**20**	**14**	**0**	**8**	**20**

NOTE: Summer Training (6-8 Weeks) is mandatory for each student to continue the program and their evaluation will be done in the Semester-III.

SEMESTER – III

Sl. No.	Course Code	Course Name	Credits		L	T	P	C
1	MALB 201	Engineering Mathematics-II	3	3	3	0	0	3
2	MEBB 211	Fluid Mechanics	3+1	4	3	0	2	4
3	MELB 201	Engineering Thermodynamics	3	3	3	0	0	3
4	MELB 202	Mechanics of Materials	3	3	3	0	0	3
5	MEPB 221	Computer Aided Machine Drawing	1	1	0	0	2	1
6	MEPB 222	Programming with Python	1	1	0	0	2	1
7	MEBB 212	Manufacturing Sciences-I	3+1	4	3	0	2	4
8	MEPB 223	Summer Training- I	1	1	0	0	0	1
	Total		**15+5**	**20**	**15**	**0**	**8**	**20**

SEMESTER – IV

Sl. No.	Course Code	Course Name	Credits		L	T	P	C
1	MEBB 261	Kinematics & Dynamics of Machines	3+1	4	3	0	2	4
2	MEBB 262	Heat and Mass Transfer	3+1	4	3	0	2	4
3	MEBB 263	Engineering Metrology & Instrumentation	2+1	3	2	0	2	3
4	MELB 251	Manufacturing Sciences-II	3	3	3	0	0	3
5	MELB 252	Design of Machine Elements	3	3	3	0	0	3
6	MEPB 271	Programming with MATLAB	1	1	0	0	2	1
7	MEPB 272	Project-II	2	2	0	0	0	2
	Total		**14+6**	**20**	**14**	**0**	**6**	**20**

NOTE: Summer Training (6-8 Weeks) is mandatory for each student to continue the program and their evaluation will be done in the Semester-V.

SEMESTER – V

Sl. No.	Course Code	Course Name	Credits		L	T	P	C
1	MEBB 311	IC Engines & Gas Turbines	3+1	4	3	0	2	4
2	MEBB 312	Fluid Machinery	3+1	4	3	0	2	4
3	MEBB 313	CAD/CAM	3+1	4	3	0	2	4
4	MEBB 314	Industrial Engineering	3+1	4	3	0	2	4
5	EELB 311	Control Systems & Engineering	3	3	3	0	0	3
6	MEPB 321	Summer Training-II	1	1	0	0	0	1
	Total		**15+5**	**20**	**15**	**0**	**8**	**20**

SEMESTER – VI

Sl. No.	Course Code	Course Name	Credits		L	T	P	C
1	MELB 351	Optimization & Simulation in Engineering Applications	3	3	3	0	0	3
2	MEBB 361	Manufacturing Automation & Robotics	3+1	4	3	0	2	4
3	MEBB 362	Mechatronics Engineering	3+1	4	3	0	0	4
4	MEBB 363	Heating, Ventilation & Air conditioning (HVAC)	3+1	4	3	0	2	4
5	MELB 38X	Program Elective-1	3	3	2	0	0	3
6	MEPB 371	Project-III	2	2	0	0	0	2
	Total		**15+5**	**20**	**15**	**0**	**4**	**20**

NOTE: Summer Training (6 - 8 Weeks) is mandatory for each student to continue the program and their evaluation will be done in the Semester-VII.

SEMESTER –VII

Sl. No.	Course Code	Course Name	Credits		L	T	P	C
1	MELB 401	Additive Manufacturing	3	3	3	0	0	3
2	CSLB 40X	Artificial Intelligence & Machine Learning	3	3	3	0	0	3
3	MELB 43X	Program Elective-2	3	3	3	0	0	3
4	MELB 43X	Program Elective-3	3	3	3	0	0	3
5	XXXXXX	Open Elective-1	3	3	3	0	0	3
6	XXXXXX	Open Elective-2	3	3	3	0	0	3
7	MEPB 421	Seminar	1	1	0	0	4	1
8	MEPB 422	Summer Training – III	1	1	0	0	0	1
	Total		**18+2**	**20**	**18**	**0**	**4**	**20**

SEMESTER – VIII

Sl. No.	Course Code	Course Name	Credits		L	T	P	C
1	MELB 48X	MOOCs (Program Elective-4)	3	3	3	0	0	3
2	XXXXXX	MOOCs (Open Elective-3)	3	3	3	0	0	3
3	MEPB 471	Major Project	14	14	0	0	0	14
	Total		**6+14**	**20**	6	0	0	**20**

NOTE: MOOC's courses approved by the Department only be studied by the students.

4.2 Program Elective Courses

Track	Program Elective-1	Program Elective-2	Program Elective-3
Manufacturing	Quality Management Systems & Accreditations	Mathematical Modeling of Manufacturing Processes	Mechanical Behavior & Testing of Materials
	Smart Materials & Structures	Mechanics of Composite Materials	Computer Integrated Manufacturing
	Product Design & Development	Flexible Manufacturing Systems	Digital Manufacturing
	Micro and Nano Manufacturing	Theory of Metal Cutting	Design and Analysis of Management Information Systems
	Lean Manufacturing		
Design	Fracture Mechanics	Dynamics of Mechanical Systems	Engineering Tribology
	MEMS Devices – Design and Fabrication	Advanced FEM	Human Factors in Engineering and Design
	Vibration and Noise	Theory of Elasticity	Bio-mechanics
Thermal	Power Plant Engineering	Hybrid and Electrical Vehicles	Alternate Fuels for IC Engines
	Applied Thermodynamics	Solar Thermal Processes	Vehicular Pollution
	Non-Conventional Energy Resources	Computational Fluid Dynamics	Combustion Generated Pollution & Control
	Heat Exchanger Technology	Cryogenics	Conduction/Convective Heat Transfer
	Automobile Engineering		

*The List of program Electives offered by the Department is tentative and will be reviewed on yearly basis and depending upon the requirements of the Industry/ Availability of faculties the program electives will be offered. ** The Open Electives will be selected by the students from the Electives offered by other Department for their BTech programs.

4.3 MOOCs

MOOCs (Program Elective-4)	MOOCs (Open Elective-3)
• Quality Control in Manufacturing	• Data Science
• Aerodynamics	• Internet of Things
• Robotics	• Information and Communication Technologies (ICT)
• Thermodynamics of Cryogenic System	• Introduction to Game Development
• Physics of Turbulent Flow	• Importance of Safety
• Industry 4.0	• Industrial Internet of Things (IIoT)

4.4 Courses offered to other Departments

Sl. No.	Course Code	Course Name	Credits		L	T	P	C
1	MEBB 119	Engineering Graphics and AutoCAD	2+1	3	2	0	2	3
2	MEBB163	Engineering Workshop Practice	1+1	2	1	0	2	2
3	MEBB 162	Engineering Visualization	3+1	4	3	0	2	4
4	MEPB 121	Product Design & Realization Lab	1	1	0	0	2	1
5	MELB 151	Engineering Mechanics	3	3	3	0	0	3

Semester-I

Sl. No.	Course Code	Course Name	Credits		L	T	P	C
1	MALB 101	Engineering Mathematics-I	3	3	3	0	0	3
2	PHBB 111	Engineering Physics	3+1	4	3	0	2	4
3	MEBB 111	Introduction to Manufacturing Technology	3+1	4	3	0	2	4
4	HMLB 101	Communication Skills	2	2	2	0	0	2
5	CSBB 111	Computer Programming	2+1	3	2	0	2	3
6	MELB 101	Introduction to Sensors, Actuators & IoT	2	2	2	0	0	2
7	MEPB 122	Joy of Engineering	1	1	0	0	2	1
8	HSPB 150	Holistic Health & Sports	1	1	0	0	2	1
	Total		**15+5**	**20**	**15**	**0**	**10**	**20**

Course no: **MEBB 111**	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**Yes**	**No**
Type of Course	**Theory**		Core Engineering Course	
Course Title	**Introduction to Manufacturing Technology**			
Course Coordinator				
Course objectives:	This subject provides information about the basics of manufacturing processes and tools/ equipment. This course also provides the uses of conventional machines. In this order, students will come to know about various manufacturing processes and it's applications with working principles.			
Course Outcomes (COs)	CO-1	Identify the process requirements to manufacture a specific product by manufacturing processes.		
	CO-2	Provide the knowledge of the effects of various operations on the quality of the product produced.		
	CO-3	Describe theoretical knowledge of physical processes occurring on machines and tools.		
	CO-4	Assess the quality of products made by different types of welding operations.		
	CO-5	Understand the forming and machining process in detail with trail experiments.		
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	2	4	**48**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	NIL				
Text Books:					
	1. Manufacturing Science by Ghosh and Mallik, East West Press. 2. Workshop Technology by Hajra Choudhary , MMP				

Reference Books:	
	1. Manufacturing Engineering and Technology, by Kalpakjian (Author) 2. Fundamentals of Machining Processes: Conventional and Nonconventional Processes Byby Hassan El-Hofy (Author) 3. Machining and Machine Tools, by A.B. Chattopadhyay (Author).
Content	**Unit - I** **Introduction**- Definitions and broad grouping, Safety and Precautions in Workshop, Types of manufacturing: According Material Uses, Types of manufacturing Processes, Tools and equipment. **Unit - II** **Casting -** Introduction, History, Definition, Major Classification Casting Materials, Sand mould casting Moulding sands: composition types, methods, Advantages & Disadvantages casting, Principle & Applications casting, Casting defects. **Unit - III** **Welding -** Introduction to metallic parts, Major grouping of joining processes, brazing and soldering, Broad classification of welding processes, Advantages & Disadvantages welding, Principle & Applications welding, Welding defects. **Unit - IV** **Forming Processes-**Forging Introduction, definition, classification, hot forging & cold forging, characteristics & applications forging, material operations, equipment's & tools: Smith forging Drop forging Pressing or press forging, Forging dies. **Unit - V** **Machining-** Definition, Introduction of Lathe Machine, Types of Lathe machine, Part of Lathe, Operations of Lathe machine, Advantages and disadvantage, Application and Principle of Lathe Machine.
Course Assessment	**Theory (100%):** Continuous Evaluation 25%, Mid Semester 25% End Semester 50% **Laboratory (100%):** Continuous Evaluation 50%, End Semester 50%

Manufacturing Technology Lab

List of Experiments

Exp. no. Description

Introduction to product design

1. To study different tools used in SolidWorks.
2. 2D and 3D part design in SolidWorks.

Fitting shop

1. To study about different hand tools used in fitting shop.
2. To make a V-Fit from the given mild steel pieces with specified dimensions.
3. To make a square fit from the given mild steel pieces with specified dimensions

Machine shop

1. To study of different parts of Lathe machine**.**
2. To perform turning and grooving operations on the given work piece in lathe machine.
3. To perform facing, knurling, thread cutting operations on the given work piece in lathe machine.

Foundry shop

1. To study the different tools used in Foundry shop.
2. To prepare a pattern and moulding box for bench moulding process and sand mould casting in Foundry Shop.
3. To determine the green shear strength of the given specimen for different percentages of clay and moisture.

Welding shop

1. To make a lap joint of the given mild steel pieces by arc welding.
2. To make a butt joint of the given mild steel pieces by arc welding.
3. To make a T joint of the given mild steel pieces by arc welding.

Sheet metal shop

1. To study different types of Hand tools used in Sheet metal shop.
2. To prepare a square tray of given dimensions using a Galvanized iron (G.I) sheet.
3. To prepare a Funnel of given dimensions using a G.I. sheet.

Course no: **MELB 101**	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**Yes**	**No**
Type of Course	**Theory**		Core Engineering Course	
Course Title	**Introduction to Sensors, Actuators & IoT**			
Course Coordinator				
Course objectives:	1. To make students know the IoT eco system. 2. To provide an understanding of the technologies and the standards relating to the Internet of Things. 3. To develop skills on IoT technical planning.			
Course Outcomes (COs)	CO-1	To understand the basics of Networking and Security.		
	CO-2	To understand predecessor of IoT technology and emergence of Internet of Things.		
	CO-3	To understand architecture for Internet of Things.		
	CO-4	To recognize various devices, sensors, actuators, and various processing paradigms for IoT.		

Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	2	0	0	2	**24**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	NIL				

Text Books:

1. Internet of Things, Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, John Wiley & Sons.
2. Sudip Mishra, Anandarup Mukherjee, Arijit Roy: Introduction to IOT, Cambridge University Press.

Reference Books:

1. Bassi, Alessandro, etal, "Enablingthingstotalk",Springer-VerlagBerlin-2016
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017
3. Massimo Banzi, Michael Shiloh Make: Getting Started with the Arduino, Shroff Publisher/ Maker Media Publishers.

Content	**UNIT - I** Basics of Networking & Basics of Network Security: Network Types, Layered Network Models, Addressing, Internet of Things TCP/ IP Transport layer, Security, Network Confidentiality, Message Integrity and Authenticity, Digital signatures, Key Management, Internet Security & Firewall. **UNIT - II** Predecessors of IoT & Emergence of IoT–Introduction, Wireless Sensor Networks, Machine-to-Machine Communications, Cyber Physical Systems, Architectural components of CPS, IoT versus M2M, IoT versus CPS, IoT versus WoT, Enabling IoT and the Complex Interdependence of Technologies, IoT Networking Components, Addressing Strategies in IoT. **UNIT - III** IoT Sensing and Actuation & IoT Processing Topologies and Types: Introduction, Sensors, Sensor Characteristics, Sensorial Deviations, Sensing Types, Sensing Considerations, Actuators, Actuators Types, Actuator Types, Actuator Characteristics, Data Formats, Processing in IoT, Processing Topologies, IoT Device Design and Selection Considerations, Processing Off loading, Off load location, Off load decision making, Off loading considerations. **UNIT - IV** IoT Sensing and Actuation & IoT Processing Topologies and Types: Introduction, Sensors, Sensor Characteristics, Sensorial Deviations, Sensing Types, Sensing Considerations, Actuators, Actuators Types, Actuator Types, Actuator Characteristics, Data Formats, Processing in IoT, Processing Topologies, IoT Device Design and Selection Considerations, Processing Off loading, Off load location, Off load decision making, Off loading considerations.
Course Assessment	Theory (100%): Continuous Evaluation 25%, Mid Semester 25% End Semester 50%

Course no: **MEPB 122**	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**Yes**	**No**
Type of Course	**Theory**		Core Engineering Course	
Course Title	**Joy of Engineering**			
Course Coordinator				
Course Objectives:	This subject provides information about creative and innovative learning. In this order, students will come to know about the basics of digital manufacturing through designing software. Additive manufacturing is also be a part of this subject.			
Course Outcomes (COs)	CO-1	Understand the fundamental knowledge of basic design software in 2-D and 3-D.		
	CO-2	Understand the working principle of 3-D Polymer and Metal printers.		
	CO-3	Familiarize the students with the 3-D printer and Design software's.		
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	0	0	2	1	**24**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	NIL				

Text Books:

1. A Practical Guide to Design for Additive Manufacturing, Diegel, Olaf, Axel Nordin, and Damien Motte, Springer, 2020.
2. The 3D Printing Handbook: Technologies, Design and Applications, Redwood, Ben, Filemon Schoffer, and Brian Garret, 3D Hubs, 2017.
3. Mathematical Elements for Computer Graphics, David F. Rogers, J. A. Adams, TMH, 2008.

Reference Books:

1. Additive Manufacturing Technologies, Gibson, Ian, David W. Rosen, Brent Stucker, and MahyarKhorasani, Springer, 2021.

	2. Laser-Induced Materials and Processes for Rapid Prototyping, L.Lu, J. Y. H. Fuh and Y.S. Wong, Springer, 2001. 3. Rapid Prototyping: Laser-based and Other Technologies, Patri K. Venuvinod and Weiyin Ma, Springer, 2004.
Content	**Fundamentals of Design Software:** Concepts, 3D Design, Component Based Terminology, User Interface, Windows Functions, Windows, Function Selection and Feedback Design Process, Design Intent, Design Method, Sketches, Origin, Planes, Dimensions, Relations, Features, Assemblies, Drawings, Model Editing. **Polymer Printer:** Support Material, Accuracy, Tolerances, Layer Thickness, Resolution, Print Orientation, over sintering, Hollowing Parts, Horizontal Bridges, Connections, Fill Style, holes, fillets, ribs, font sizes and small details. **Metal Printer:**, Warpage and Support Material, Design Guidelines for Wall Thickness, Clearance Between Moving Parts, Vertical Slots, Circular Holes, fillets, channels, vertical Bosses, circular pins, External Screw Threads and part positioning.
Course Assessment	**Laboratory (100%):** Continuous Evaluation 50%, End Semester 50%

Semester-II

Sl. No.	Course Code	Course Name	Credits		L	T	P	C
1	MEBB 161	Engineering Materials	3+1	4	3	0	2	4
2	MELB 151	Engineering Mechanics	3	3	3	0	0	3
3	MEBB 162	Engineering Visualization	3+1	4	3	0	2	4
4	EEBB 161	Introduction to Electrical & Electronics Engineering	3+1	4	3	0	2	4
5	CELB 101	Environmental Sciences	2	2	2	0	0	2
6	HMPB 171	Technical Report Writing	1	1	0	0	2	1
7	MEPB 171	Project-I	2	2	0	0	0	2
8	EAP 101	Extra Academic Activity	0	0	0	0	2	0
	Total		**14+6**	**20**	**14**	**0**	**10**	**20**

Course no: **MEBB 161**	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**Yes**	**No**
Type of Course	**Theory**		Core Engineering Course	
Course Title	**Engineering Materials**			
Course Coordinator				
Course objectives:	The objective of the course is to provide basic understanding of engineering materials. To understand the concepts of atomic bonding, crystal structures, imperfections, diffusions, mechanical properties, and dislocations as related to processing and performance of engineering materials. Understand the relations between the composition, temperature and phase diagrams for given material systems. To understand the various issues in engineering materials during the selection of materials for the various applications.			
Course Outcomes (COs)	CO-1	Understand the basic knowledge and classify the different types of engineering materials.		
	CO-2	Discuss the mechanical behaviour and various strengthening mechanisms of engineering materials.		
	CO-3	Describe the isomorphous and eutectic phase diagram.		
	CO-4	Applications of electrical and magnetics materials.		
	CO-5	Identify the form of degradation of materials and suggest methods to prevent it.		
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	2	4	**48**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	NIL				
Text Books:					

	1. W.D. Callister, Materials Science and Engineering; John Wiley & Sons, Singapore. 2. W.F. Smith, Principles of Materials Science and Engineering: An Introduction; Tata Mc-Graw Hill. 3. V. Raghavan, Introduction to Materials Science and Engineering; PHI, Delhi. 4. J. F. Shackelford: Introduction to Materials Science for Engineers, Mc-Millan Publishing Co., N.Y.
Reference Books:	
	1. S. O. Kasap, Principles of Electronic Engineering Materials; Tata Mc-Graw Hill. 2. L. H. Van Vlack, Elements of Material Science and Engineering; Thomas Press, India. 3. K. G. Budinski, Engineering Materials – Properties and selection, Prentince Hall India. 4. Michael F. Ashby, David R. H. Jones Engineering Materials 1 An Introduction to Properties, Applications, and Design, Fourth Edition, ELSEVIER 5. Mechanical Behavior of Materials by Krishan Chawla, Marc A. Meyers, Cambridge university press.
Content	**UNIT - I** **Structure of Solids:** Classification of engineering materials, Structure-property relationship in engineering materials, Crystalline and non-crystalline materials, Miller Indices, Crystal planes and directions, Inorganic solids, Silicate structures and their applications. Crystal imperfections-Point, line and surface defects. **UNIT - II** **Mechanical Properties:** Elasticity and Plasticity in Materials, Stress-strain curve, Tensile properties, Hardness and Hardness measurement, Impact properties, Fatigue, Creep, Optical Microscopy, Optical microscope - Basic principles and components. **UNIT - III** **Equilibrium Diagram:** Solids solutions and alloys, Gibbs phase rule, Unary and binary eutectic phase diagram, Examples and applications of phase diagrams like Iron - Iron carbide phase diagram. **UNIT - IV** **Electrical and Magnetic Materials:** Conducting and resistor materials, and their engineering application; Semiconducting materials, their properties and applications; Magnetic materials, Soft and hard magnetic materials and applications; Superconductors; Dielectric materials, their properties and applications. Smart materials: Sensors and actuators, piezoelectric, magnetostrictive and electrostrictive materials. **UNIT V:** **Environmental Degradation of materials:** Environmental Degradation of metals (corrosion), ceramics, and polymers, Cause of corrosion, Types of corrosion, Protection against corrosion. Selection of materials for different engineering applications. Recycling Issues in Materials.

Course Assessment	**Theory (100%):** Continuous Evaluation 25%, Mid Semester 25% End Semester 50% **Laboratory (100%):** Continuous Evaluation 50%, End Semester 50%

Material Testing Lab

List of Experiments:

1. To study cooling curve of a binary alloy.
2. To study the stress -strain characteristics of (a) Mild Steel by conducting tension test on Universal Testing Machine.
3. To perform compression test on Universal Testing Machine.
4. To determine the shear strength of a given specimen on Universal Testing Machine.
5. To find the Brinnell's and Vicker's hardness numbers of (a) Steel (b) Brass (c) Aluminium (d) Copper by conducting hardness test.
6. Study of Impact Testing Machine and to perform Izod Test to find the Impact strength of the given specimen.
7. To determine the Modulus of rigidity by conducting Torsion test on (a) Solid shaft (b) Hollow shaft.
8. To determine the Modulus of elasticity of the material by conducting deflection test on a continuous beam.
9. To find the Modulus of rigidity of the material of a spring by conducting Compression test.
10. To determine the Young's modulus of the material by conducting deflection test on a simply supported beam.
11. To investigate creep of a given wire at room temperature.
12. To perform Bending Test on Cantilever Beam set up and calculate the Bending Stress.

1.

Course no: **MELB 151**	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**Yes**	**No**
Type of Course	**Theory**		Core Engineering Course	
Course Title	**Engineering Mechanics**			
Course Coordinator				
Course objectives:	1. To apply the knowledge of mathematics, Science and Engineering and to expand this into the vast area of 'rigid body mechanics'. 2. To impart knowledge about the basic laws of statics and their applications in problem solving. 3. To enhance the ability to design and solve open ended problems. 4. To prepare the students for higher level of courses in the demine of mechanical engineering.			
Course Outcomes (COs)	CO-1	Apply the various laws of engineering mechanics for solving simple and complex problems.		
	CO-2	Apply analytical skills for analysing statically equilibrium problems.		
	CO-3	Understand and analyse support reactions in various types of beams.		
	CO-4	Calculate and analyse the centre of gravity and centroid of the rigid bodies.		
	CO-5	Calculate and analyse the area moment of inertia and mass moment of inertia of the rigid bodies.		
	CO-6	Solve problems related to friction.		
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	NIL				

Text Books:	
	1. Engineering Mechanics by Shames & Rao – Pearson Education, 2005. 2. Engineering Mechanics by Dr. R.K. Bansal, Lakshmi Publications, 2009. 3. Engineering Mechanics – B. Bhattacharyya, Oxford University Publications, 2008. 4. Engineering mechanics by S S Bhavikatti, New age International Publications, 2017.
Reference Books:	
	1. Engineering Mechanics by Fedrinand L.Singer – Harper Collings Publishers, 1994. 2. Engineering Mechanics by Seshigiri Rao, Universities Press, Hyderabad, 2005. 3. Engineering Mechanics by Rajsekharan, Vikas Publications, 2005. 4. Engineering Mechanics (Statics and Dynamics) by Hibller and Gupta; Pearson Education, 2016. 5. Engineering Mechanics by S.Timoshenko, D.H.Young and J.V.Rao, Tata McGraw-Hill Company, 2013. 6. Engineering Mechanics by Chandramouli, PHI publications, 2011. 7. Engineering Mechanics –Arthur P. Boresi and Richard J. Schmidt. – Brooks/Cole – Cengage, 2002.
Content	**UNIT - I** **Introduction to Engineering Mechanics**- classification of engineering mechanics – basic terminologies in mechanics - units and dimensions – laws of mechanics – parallelogram and triangular law of forces – Lame‟s theorem- principle of transmissibility – single equivalent force – simple problems. **UNIT - II** **Equilibrium of rigid body**- composition system of forces – resolution of forces – general method of composition of forces – equilibrium of bodies – equilibrium of connected bodies – simple examples - Moment of a force – Varignon‟s theorem – couple – resultant of non-concurrent force system- x and y intercept of resultant- simple problems. **UNIT - III** **Support Reactions- introduction** – types of supports – types of loading – analytical method for finding out the reactions of a beam – simple problems on simply supported beams, overhanging beams and roller and hinged supports beams. **UNIT- IV** **Center of gravity and centroid** – Determination of areas – First moment of area and the centroid of sections – Rectangle, circle, triangle from integration – T-section, I-section, angle section, hollow sections by using standard formula. **UNIT - V** **Area moment of inertia and mass moment of inertia** – Introduction – radius of gyration – theorem of perpendicular axis – theorem of parallel axis – second moment of area – rectangle, circle, triangle from integration – T-section, I-section, angle section, hollow section by using standard formula – polar moment of inertia – mass moment of inertia.

	UNIT - VI **Friction**- Introduction - Types of friction - laws of Coulomb friction – Frictional force –Angle of repose –Equilibrium of a body lying on rough inclined plane – Analysis of ladder friction – Analysis of wedge friction.
Course Assessment	**Theory (100%):** Continuous Evaluation 25%, Mid Semester 25% End Semester 50%

<table>
<tr><td>Course no:
MEBB 162</td><td colspan="2">Open course (YES/NO)</td><td>HM Course (Y/N)</td><td colspan="2">DC (Y/N)</td><td>DE (Y/N)</td></tr>
<tr><td></td><td colspan="2">No</td><td>No</td><td colspan="2">Yes</td><td>No</td></tr>
<tr><td>Type of Course</td><td colspan="2">Theory & Practical</td><td></td><td colspan="2"></td><td></td></tr>
<tr><td>Course Title</td><td colspan="6">ENGINEERING VISUALIZATION</td></tr>
<tr><td>Course Coordinator</td><td colspan="6"></td></tr>
<tr><td>Course objectives:</td><td colspan="6">1. To impart and inculcate proper understanding of the theory of projection.
2. To improve the visualization skills.
3. To enable the students with various concepts like dimensioning, conventions and standards related to working drawings in order to become professionally efficient.
4. To impart the knowledge on understanding and drawing of simple residential/office buildings.</td></tr>
<tr><td rowspan="5">Course Outcomes (Cos)</td><td>CO-1</td><td colspan="5">Remember the use of different instruments used in Engineering Drawing and Importance of BIS and ISO codes.</td></tr>
<tr><td>CO-2</td><td colspan="5">Illustrate various types of mathematical curves and scale.</td></tr>
<tr><td>CO-3</td><td colspan="5">Construct orthographic projection of Point, Line, and Plane</td></tr>
<tr><td>CO-4</td><td colspan="5">Construct orthographic and sectioning views of regular solids.</td></tr>
<tr><td>CO-5</td><td colspan="5">Create Orthographic view to Isometric projection/view and vice-versa.</td></tr>
<tr><td>Semester</td><td colspan="2">Autumn:</td><td colspan="4">Spring:</td></tr>
<tr><td></td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Credits</td><td colspan="2">Total Teaching Hours</td></tr>
<tr><td>Contact Hours</td><td>3</td><td>0</td><td>2</td><td>4</td><td colspan="2">48</td></tr>
<tr><td>Prerequisite course code as per proposed course numbers</td><td></td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>Prerequisite Credits</td><td></td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>Equivalent course codes as per proposed course and old course</td><td></td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>Overlap course codes as per proposed course numbers</td><td>NIL</td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td colspan="7">Text Books:</td></tr>
<tr><td></td><td colspan="6">1. Engineering Graphics, N.D. Bhatt and V.M. Panchal, Charotar Publishers.
2. Jolhe, D. A., Engineering drawing, Tata McGraw Hill</td></tr>
</table>

Reference Books:	
	1. Engineering Drawing, Agarwal, B, McGraw Hill Education, 2015, Second edition. 2. Shah, M. B. and Rana, B. C., Engineering Drawing, Pearson Education, 2009 3. K.V. Natarajan, A text book of Engineering Graphics, Dhanalakshmi Publishers, Chennai, 2006. 4. AutoCAD 2007 Bible E. Finkelstein,Wiley Publishing Inc.
Content	**UNIT - I** **Lines Lettering and Dimensioning:** Types of lines, Lettering, Dimensioning, Geometrical Constructions, Polygons. Scales: Plain scales, Diagonal scales, Scale of chords. **UNIT - II** **Curves used in Engineering Practice:** Ellipse, Parabola, Hyperbola, normal and tangents to these curves, Involute, Cycloid, Epi-cycloid, Hypo-cycloid, Spiral, Helix on cone and cylinder. **UNIT- III** **Orthographic projection of points:** Principles of Orthographic projection, Projections of points. Projections of Lines: Projections of a line parallel to one of the reference planes and inclined to the other, line inclined to both the reference planes, Traces, Projections of Planes: Projections of a plane perpendicular to one of the reference planes and inclined to the other, Oblique planes. **UNIT - IV** **Projections of Solids:** Projections of solids whose axis is parallel to one of the reference planes and inclined to the other, axis inclined to both the planes. Section of Solids: Sectional planes, Sectional views - Prism, pyramid, cylinder and cone, true shape of the section. **UNIT - V** **Isometric views:** Isometric axis, Isometric Planes, Isometric View, Isometric projection, Isometric views – simple objects. Assembly drawings of the machine parts. **NOTE:** Interpretation of drawings: Introduction of CAD package to construct a simple solid model, using a CAD package to construct solid models and generating orthographic, isometric, sectional views with dimensioning, Assembly of components and generation of corresponding drawings. Animation of machines in CAD.
Course Assessment	**Theory (100%):** Continuous Evaluation 25%, Mid Semester 25% End Semester 50% **Laboratory (100%):** Continuous Evaluation 50% , End Semester 50%

Engineering Visualization Lab

The objective of this lab is to learn the basics of engineering drawing and implement the knowledge of this subject as an engineering design. The lab curriculum is designed for 1st year UG students for all engineering specializations. At the end of the course students will be able to implement their ideas in various applications and create job opportunities.

Major Equipments:

Drawing sheet, Drawing board, Mini drafter, HB/1H/2H Pencils, Eraser, Protractor, scale, etc or using Autocad

List of Experiments

S. No.	Description
1.	Lettering, Dimensioning,
2.	Plan Scale, Diagonal Scale, Scale of Chords
3.	Geometrical construction of Engineering Curves
4.	Introduction of Projection of Points and Lines
5.	Traces of lines
6.	Projection of Planes
7.	Projections of Regular Solids
8.	Sectional Views of Solids
9.	Isometric views
10.	Orthographic to isometric

Course no: **MEPB 171**	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**Yes**	**No**
Type of Course	**Training**			
Course Title	**Project- Summer Training**			
Course Coordinator				
Course Objectives:	Students may complete the training before the beginning of 3rd semester and register for it in 3rd semester. The duration of the internship or practical training will be for a minimum of 4 weeks. Practical training or Internship must be undertaken in physical/ online mode in industry/R&D organizations/Premier educational institutes. Practical training or Internship must focus on mechanical engineering domain.			
Course Outcomes (COs)	CO-1	Exposure to the professional world of engineering and research.		
	CO-2	Correlation of theoretical knowledge with the application practice.		
	CO-3	Learning technical report writing.		
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	0	0	0	2	-
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	NIL				

Text Books:	
	As applicable
Reference Books:	
	As applicable
Content	As applicable
Course Assessment	Report submission and presentation

SEMESTER-III

Sl. No.	Course Code	Course Name	Credits		L	T	P	C
1	MALB 201	Engineering Mathematics-II	3	3	3	0	0	3
2	MEBB 211	Fluid Mechanics	3+1	4	3	0	2	4
3	MELB 201	Engineering Thermodynamics	3	3	3	0	0	3
4	MELB 202	Mechanics of Materials	3	3	3	0	0	3
5	MEPB 221	Computer Aided Machine Drawing	1	1	0	0	2	1
6	MEPB 222	Programming with Python	1	1	0	0	2	1
7	MEBB 212	Manufacturing Sciences-I	3+1	4	3	0	2	4
8	MEPB 223	Summer Training- I	1	1	0	0	0	1
	Total		**15+5**	**20**	**15**	**0**	**8**	**20**

Course no: MEBB 211	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	**No**	**Yes**	**No**
Type of Course	**Theory and Practical**		Core Engineering Course	
Course Title	**Fluid Mechanics**			
Course Coordinator				
Course Objectives:	The student is introduced to the mechanics of fluids through a thorough understanding of the properties of fluids. The dynamics of fluids is introduced through the control volume approach which gives an integrated understanding of the transport of mass, momentum and energy. To impart method of determination of major and minor losses in pipes			
Course Outcomes (COs)	CO-1	Understand the properties of fluids, basic principles & applications of fluid mechanics.		
	CO-2	Apply conservation laws to fluid flow problems in engineering applications.		
	CO-3	Evaluate the kinematics of fluid flow.		
	CO-4	Analyse laminar and turbulent flow.		
	CO-5	Create physical models with the basics concept of Boundary Layer.		

Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	2	4	**48**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	NIL				

Text Books:	
	1. Çengel, Y.A. and J.M. Cimbala, Fluid Mechanics, McGraw-Hill, Boston, MA. 2. Munson, B.R., D.F. Young, and T.H. Okiishi, Fundamentals of Fluid Mechanics, 4th Ed., Wiley, New York, NY, 2002. 3. Som, S. K., Biswas, G. and Chakraborty, S., "Introduction to Fluid Mechanics and Fluid Machines", 3rd 2012 Ed., Tata McGraw Hill
Reference Books:	
1.	1. White, F.M., "Fluid Mechanics", 7th Ed., McGraw-Hill 2. Shames, Mechanics of Fluids, McGraw Hill Book Co., New Delhi, 1988 3. Streeter V.L. and Benjamin Wylie, Fluid Mechanics, McGraw Hill Book Co., New Delhi, 1999. 4. Yuan, S.W., "Foundation of Fluid Mechanics", 2nd Ed., Prentice-Hall
Content	**UNIT -I** **Introduction:** Fluids and their properties: Ideal and real fluids, capillarity, Vapour pressure, compressibility and bulk modulus, Newtonian and non-Newtonian fluids. **Fluid Statics:** Concept of pressure, Pascal's law and its engineering applications, action of fluid pressure on a plane (horizontal, vertical and inclined) submerged surface, resultant force and centre of pressure, Buoyancy and flotation, stability of floating and submerged bodies, Metacentric height. **UNIT-II** **Fluid Kinematics:** Classification of fluid flows, velocity and acceleration of fluid particle, normal and tangential acceleration, streamline, path line and streak line, Circulation and Vorticity, Velocity Potential Function, Stream Function, Flow Net, Acceleration in Fluid Vessel, flow rate and discharge mean velocity, continuity equation. **UNIT-III** **Fluid dynamics:** Reynolds transport theorem; Conservation equations of mass, momentum and energy, Navier-Stokes, Euler and Bernoulli equations; Forces due to fluid flow over flat plates, curved vanes and in the bends, applications of Bernoulli equation, Flow Measurement: Flow measuring devices, Pitot tube, obstruction flow meters. **UNIT-IV** **Laminar and Turbulent Flows:** Flow through Pipes, Hagen Poiseuille Flow, Stokes Law, Transition from Laminar to Turbulent Flow, Types of Turbulent Flow, Scale and Intensity of Turbulence, Eddy Viscosity, Prandtl Mixing Length Theory, Velocity Distribution in Turbulent Flow, Major and Minor Losses, Moody's Diagram, Pipe in Series and Parallel, Pipe Network. **UNIT-V** **Dimensional analysis:** Basic and derived quantities, similitude and dimensional analysis, Buckingham π–theorem, non-dimensional parameters, model testing

	Boundary Layer Theory: Concept of boundary layer, Equations and Approximate Integral Analysis, Boundary Layer Separation and its Control, Thermal Boundary Layer
Course Assessment	**Theory (100%):** Continuous Evaluation 25%, Mid Semester 25% End Semester 50% **Laboratory (100%):** Continuous Evaluation 50%, End Semester 50%

Fluid Mechanics Lab

The objective of this lab is to learn the basics of fluid mechanics and implement the knowledge of this subject as an engineering design and analyse of fluid flow. The lab curriculum is designed for 2nd year UG students for Mechanical engineering. At the end of the course students will be able to implement their ideas in various applications and create job opportunities.

List of Experiments

S.No.	Description
1.	To find the metacentric height of the floating body.
2.	To determine coefficient of discharge (Cd) of Orifice.
3.	To determine coefficient of discharge (Cd) of Venturimeter.
4.	To determine the coefficient of discharge (Cd) of Rectangular notch.
5.	To determine the coefficient of discharge (Cd) of the V notch.
6.	To verify Bernoulli's theorem using a Venturimeter.
7.	To find the friction loss and frictional factor of given pipe lines.
8.	To study the inception and growth of Cavitation.
9.	Flow visualization/patterns
10.	Impact of Jet

Course no: MELB 201	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	**No**	**Yes**	**No**
Type of Course	**Theory**		Core Engineering Course	
Course Title	**Engineering Thermodynamics**			
Course Coordinator				
Course objectives:	1. To learn the principles of work and energy. 2. To acquire knowledge about the fundamentals of thermodynamic laws, concepts and principles. 3. To understand the principles of various cycles and to apply the thermodynamic concepts in various applications like IC engines and steam plants.			
Course Outcomes (COs)	CO-1	Understand the concepts of thermodynamic systems, properties and laws of thermodynamics.		
	CO-2	Apply the first law of thermodynamics for non-flow and flow processes.		
	CO-3	Apply the second law of thermodynamics for closed and open systems		
	CO-4	Evaluate the quality of steam and properties of pure substances		
	CO-5	Analyse Gas and vapour power cycles		

Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	NIL				

Text Books:	
	1. Cengel, Y.A. and Boles, M.A., "Thermodynamics an Engineering Approach", Tata McGraw-Hill 2. Nag, P.K., "Engineering Thermodynamics", Tata-McGraw Hill 3. Som, S. K., Biswas, G. and Chakraborty, S., "Introduction to Fluid Mechanics and Fluid Machines", 3rd 2012 Ed., Tata McGraw Hill
Reference Books:	

	1. G.J.Vanwylen and R.E. Sonntag" Fundamentals of Thermodynamics," Wiley India 2. Arora, C.P., "Thermodynamics", Tata-McGraw Hill 3. Moran, M.J. and Shapiro, H.M., "Fundamentals of Engineering Thermodynamics", 4th 2010
Content	**UNIT-I** **Introduction:** Scope and applications of thermodynamics, Concept of continuum, microscopic and macroscopic approach, system, control volume thermodynamic system, surrounding, state, process, properties, equilibrium, heat and work, Zeroth Law of Thermodynamics. **UNIT- II** **First Law of Thermodynamics:** First law application to non-flow processes such as isochoric, isobaric, isothermal, adiabatic and polytropic processes. Steady flow energy equation, flow work. Application to various practical systems viz. nozzles, diffuser, turbines, heat exchangers etc. Application of energy equation to transient flow problems. **UNIT- III** **Second Law of thermodynamics:** Second law, reversible and irreversible processes, Clausius and Kelvin Planck statements, Carnot cycle, corollaries of second law: thermodynamic temperature scale, Clausius inequality, entropy as a property, principle of increase of entropy. Calculation of entropy change. **UNIT-IV** **Properties of Pure Simple Compressible Substance:** PvT surface, PV, TV, TP diagrams. Equation of state for ideal and real gases, van der Waal equation, use of steam tables and Mollier diagram. **UNIT- V** **Gas and Vapour Power Cycles:** Otto, Diesel, Dual, Stirling, Joule Brayton cycle. Thermal efficiency and mean effective pressure, Rankine cycle.
Course Assessment	**Theory (100%):** Continuous Evaluation 25%, Mid Semester 25% End Semester 50%

Course no: MELB 202	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	Yes	No
Type of Course	Theory		Core Engineering Course	
Course Title	Mechanics of Materials			
Course Coordinator				
Course objectives:	1. To impart basic principles of solid mechanics and their associated laws. 2. To understand the behaviour of engineering materials for different types of loads. 3. To understand the behaviour of beams under different types of loads. 4. To understand the nature of stresses developed in material under complex loading system. 5. To analyse the cylindrical shells under circumferential and radial loading conditions.			

Course Outcomes (COs)		
	CO-1	Determine the deformations, stresses and strains in members subjected to the axial and thermal load.
	CO-2	Evaluate and explain the variations of the shear forces and bending moments along the axis of the beam.
	CO-3	Use the bending stress concept to design the machine and structural components.
	CO-4	Evaluate the deflections at various points in the beam and determine the critical buckling loads of columns under different boundary conditions.
	CO-5	Analyse the principal stresses/strains and visualize the variations of normal and shear stresses in components.
	CO-6	Apply the knowledge of thin cylinders in the design of boilers, pressure vessels, and low pressure processing equipment etc., used in various industries.

Semester	Autumn:		Spring:		
	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	NIL				
Text Books:					

	1. S. Ramamrutham, Strength of materials, 16th Edition, Dhanpat Rai publications, 2011. 2. R.K. Bansal, Strength of Materials, 4th Edition, Laxmi publications (P) ltd, 2017. 3. James M. Gere, Barry J. Goodno, Mechanics of materials, 7th edition, Cengage learning, 2009.
Reference Books:	
	1. Nash W.A, Theory and problems in Strength of Materials, Schaum Outline Series, McGraw-Hill Book Co. 2. Strength of materials by Bhavikatti, Lakshmi Publications. 3. Engineering Mechanics of Solids by Popov E.P, Prentice-Hall of India, New Delhi. 4. Mechanics of solids by Timo shenko,TMH Publications. 5. Singh D.K "Mechanics of Solids" Pearson Education. 6. Beer F. P. and Johnston R, Mechanics of Materials, McGraw-Hill Book Co, Third Edition
Content	**UNIT - I** **Simple stresses & strains:** Rigid and Deformable bodies – Strength, Stiffness and Stability – Stresses; Tensile, Compressive and Shear – Deformation of simple and compound bars under axial load – Thermal stress – Elastic constants – Strain energy and unit strain energy – Strain energy in uniaxial loads. **UNIT - II** **Shear force and bending moment:** Types of beams: Supports and Loads – Shear force and Bending Moment in beams – Cantilever, Simply supported and Overhanging beams subjected to point loads, UDL, Uniformly varying loads and combination of these loads- Point of Contra flexure- Relation between S.F, B.M and rate of loading at a section of a beam. **UNIT - III** **Flexural stresses:** Theory of simple bending- Assumptions- Derivation of bending equation (M/I = f/y = E/R) – Neutral axis- Determination of Bending stresses- section modulus of rectangular and circular sections (Solid and Hollow), I, T, Angle and Channel sections. **UNIT - IV** **Beam deflection:** Elastic curve of Neutral axis of the beam under normal loads – Evaluation of beam deflection and slope: Double integration method, Macaulay Method. **Columns:** End conditions – Equivalent length of a column – Euler‟s equation – Slenderness ratio – Rankin‟s formula for columns. **UNIT - V** **Principal stresses & strains:** Principal stresses and Principal planes, Method of determining stresses on oblique sections, Mohr‟s circle. **UNIT - VI** **Cylindrical shells:** Thin cylindrical shells – Derivation of formula for longitudinal and circumferential stresses –hoop, longitudinal stresses and volumetric strains.

Course Assessment	**Theory (100%):** Continuous Evaluation 25%, Mid Semester 25% End Semester 50%				
Course no: **MEPB 221**	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)	
	No	**No**	**Yes**	**No**	
Type of Course	**Practical**		Core Engineering Course		
Course Title	**Computer Aided Machine Drawing**				
Course Coordinator					
Course Objectives:	1. To impart the basic knowledge of use of computers in product development and design. 2. To introduce the students to mathematical and computational modelling of curves, surface and solids. 3. To enable the student to use a computer for product modelling and analysis.				
Course Outcomes (Cos)	CO-1	Use mathematical concepts of curve, surface and solid formulations in CAD.			
	CO-2	Interpret drafting, tolerance and geometrical symbols in given production drawings.			
	CO-3	Prepare 2D/3D production machine drawings using design software.			
Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	0	0	2	1	**24**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	NIL				
Text Books:					
	1. A Practical Guide to Design for Additive Manufacturing, Diegel, Olaf, Axel Nordin, and Damien Motte, Springer, 2020. 2. The 3D Printing Handbook: Technologies, Design and Applications, Redwood, Ben, Filemon Schoffer, and Brian Garret, 3D Hubs, 2017.				
Reference Books:					

	1. Radhakrishnan P & Kothandaraman C.P, "Computer Graphics and Design", Dhanpat Rai & Sons, 1990. 2. Groover M P, "Automation, Production System and Computer Aided Manufacture", Prentice Hall, 1984. 3. William M Newman & Robert Sproul,, "Principle of Interactice Computer Graphics", Mc Graw Hill, 1984
Content	**Basic concepts of CAD:** CAD workstation - principles of computer graphics - graphics programming - mechanical drafting package. **Development of Surfaces**: Draw the development of surfaces for Prisms, Cylinders, Pyramids and Cones. Representation of elements of machine drawing: Engineering Materials, Surface finishes, tolerances, sectional views, Screw threads. **Component Drawings**: Bolts and Nuts, Locking devices, Keys and Cotter joints, Knuckle Joint, Riveted joints, Shaft Couplings, Bearings and Pipe joints. **Assembly Drawing Practice**: Draw the assembly drawings of Stuffing Box, Eccentric, Swivel bearing, Drill jig, Tail stock, Toolpost, Tool head for shaping machine, machine vice, screw jack, using the component drawings, Draw the component drawings using the assembly drawings, Machine Drawing practice using AutoCAD/CATIA etc.
Course Assessment	**Laboratory (100%):** Continuous Evaluation 50%, End Semester 50%

Course no: **MEBB 212**	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**Yes**	**No**
Type of Course	**Theory & Practical**			
Course Title	**Manufacturing Sciences-I**			
Course Coordinator				
Course Objectives:	1. The main objective of this course is to emphasize the importance manufacturing sciences in the day-to-day life. 2. To impart knowledge about the different processes, materials and systems in manufacturing. 3. To study and understand the basic manufacturing processes and tools used in the manufacturing processes like casing, joining, forming and powder metallurgy etc. 4. To enable the students to understand about the different types of defects in manufacturing processes such as casting, rolling, forging, drawing extrusion and welding etc.			
Course Outcomes (COs)	CO-1	Understand the basic concepts of various manufacturing processes.		
	CO-2	Analysis the design concept of core, core print and gating system in metal casting processes		
	CO-3	Examine weld joints fabricated through solid state and fusion joining, brazing and soldering techniques		
	CO-4	Develop process-maps for metal forming processes using plasticity principles		
	CO-5	Design near net shaped components from metal and ceramic powders		

Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	2	4	**48**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					

Overlap course codes as per proposed course numbers	NIL				
Text Books:					
	1. Manufacturing Science. Amitabha Ghosh and Mallick A. K, Affiliated East-West Press Pvt. Ltd. 2010. 2. Manufacturing Engineering and Technology (4th Edition) by Serope Kalpakjian, Steven R. Schmid, Prentice Hall 2000-06-15 ISBN: 0201361310. 3. Manufacturing & Technology: Foundry Forming and Welding by P.N. Rao, Tata McGraw Hill. 4. Science and Engineering of Casting Solidification, Doru Michael Stefanescu, Springer, 2009. 5. Fundamentals of Manufacturing Process, G. K. Lal and S. K. Choudhury, 2009, CRC Press, 2011. 6. Welding and Welding Technology" by Richards L. Little, Tata Mc Zgraw Hill				
Reference Books:					
	1. Materials and Processes, in Manufacturing, Paul Degarmo E, Black J.T and Ronald A. Kosher, Eight Edition, Prentice –Hall of India, 1997. 2. Solidification and Casting, Brian Cantor, Keyna O'Reilly, Taylor and Francis, 2002. 3. Formability of Metallic Materials: Plastic Anisotropy, Formability Testing, Forming Limits, Dorel Banabic, Springer, 2010. 4. Powder Metallurgy- Science, Technology and Applications, P. C. Angelo and R. Subramanian, PHI, New Delhi, 2010. 5. Fundamentals of Modern Manufacturing: Materials Processes and Systems by M. P. Groover, John Wiley and Sons, New Delhi. 6. Principles of Metal Casting" by Heine, Loper and Rosenthal, Tata Mc Graw Hill Publishing Co, Ltd; New Delhi. 7. Materials and Processes in Manufacturing by 5.E.PaulDeGarmo, J.T. Black, Ronald A. Khoser, Wiley; 9 edition, ISBN:0471033065 8. Foundry Engineering by Taylor H.F Flemings M.C&Wulff J, Wiley Eastern Limited. 9. Principles of Foundry Technology, by Tata Mc Graw Hill Publishing Company, Ltd **Online Resources:** https://www.mooc-list.com/tags/manufacturing				

Content	**UNIT- I** **Introduction to Manufacturing Processes:** Introduction and Classifications of manufacturing processes, Overview of Machining Processes, Elastic and Plastic Deformation, Crystal Imperfection and dislocation, Stress Strain Diagram for different types of materials, Control of material properties (Alloying and heat treatment, Mechanical Properties and Recrystallization). **UNIT-II** **Casting Practices:** Introduction and Classification of Casting Processes, Pattern, Pattern allowances and their importance, Mold design and Mold making procedures, Solidification of Alloys and its mechanism, Gating System Design and Estimation of Solidification time, Riser Design and Riser Placement, Casting Defects and remedies, Numerical Problems on Casting. **UNIT-III** **Joining Processes:** Introduction and Classification of Joining Processes, Physics of Welding, Types of Welding - Fusion and Solid-state welding processes, Solidification Phenomenon in Welding, Microstructural Evolution, Weldability, Welding of metals and alloys, Different Zones of Weld Region and their Microstructural Evolution, Brazing and Soldering, Defects and Remedies. **UNIT-IV** **Forming Processes:** Introduction, Classification of metal forming processes, Basic metal working concepts and plasticity, Yield criterion, Slip line fields, Estimation of force and energy requirements, Technology of bulk and sheet metal forming processes, various features of different types of metal forming dies (Rolling, Wire and Tube Drawing, Extrusion and Deep Drawing). Numerical Problems on Forming. **UNIT-V** **Powder Metallurgy:** Powder Metallurgy: (Metals and Ceramics) Techniques of near net shape manufacturing, techniques of powder manufacturing, powder compaction methods, introduction to sintering, Sintering phenomenon, post sintering operations. Numerical Problems on sintering.
Course Assessment	**Theory (100%):** Continuous Evaluation 25%, Mid Semester 25% End Semester 50% **Laboratory (100%):** Continuous Evaluation 25%, End Semester 50%

Manufacturing Science-I Lab

List of Experiments

Casting Experiments

2. Find the grain fineness number of the given moulding sand. Also, demonstration on sweep pattern and core making in mould preparation.
3. Find the green and dry shear strength, compression strength and permeability of the given moulding sand.

Welding Experiments

4. Fabricate the butt joint in the given samples by using shielded metal arc welding in the given samples.
5. Fabricate butt joint in the given samples by using gas welding, SAW, TIG and MIG welding.
6. Identify welding defects by liquid penetration test in the welded sample.

Conventional Lathe & Milling

7. To understand the operation of conventional Lathe and to fabricate a component using the Lathe machine.
8. To understand the operation of conventional Milling Machine and to fabricate a component having minimum 5 operations.

CNC Machines

9. To familiarize with the CNC Lathe and to evaluate the impact of various parameters on the accuracy and surface finish of machined components.
10. To familiarize with the CNC Milling and to evaluate the impact of various parameters on the accuracy and surface finish of machined components.
11. To understand the operation of CNC Wire Cut EDM and to fabricate a component using the wire cut EDM machine, evaluating MRR of the machining process in terms of accuracy and surface finish.

Forming Experiments

12. Fabricate the cylindrical, rectangular and square shape using sheet metal

Resources:

Text Books:

1. Manufacturing Science, Amitabha Ghosh and A. K. Mallick, Affiliated East-West Press Pvt. Ltd. 2010.
2. Manufacturing Engineering and Technology, 8th Edition, S. Kalpakjain and S. R. Schmid, Pearson.
3. Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, M. P. Groover, Wiley India Private Limited, 3rd edition, 2009.
4. Manufacturing process, Casting, Forming and Welding, 2nd Edition by H S Shan, Cambridge.

Reference Books:

1. Principles of Foundry Technology, P.L. Jain, TMH, 2014.
2. Manufacturing Technology Foundry, Forming and Welding, P.N. Rao, TMH, 2nd Edition, 2017.

Course no: **MEPB 223**	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**Yes**	**No**
Type of Course	**Training**			
Course Title	**Summer Training-I**			
Course Coordinator				
Course objectives:	A student may complete the training before the beginning of 4th semester and register for it in 4th semester. The duration of the internship or practical training will be for a minimum of 4 weeks. Practical training or Internship must be undertaken in physical/online mode in industry/R&D organizations/Premier educational institutes. Practical training or Internship must focus on mechanical engineering domain.			
Course Outcomes (COs)	CO-1	Exposure to the professional world of engineering and research		
	CO-2	Correlation of the theoretical knowledge with the application practice		
	CO-3	Learning technical report writing.		

Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	0	0	0	2	**-**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	NIL				

Text Books:	
	As applicable
Reference Books:	
	As applicable
Content	Not required
Course Assessment	Report submission and presentation

SEMESTER-IV

Sl. No.	Course Code	Course Name	Credits		L	T	P	C
1	MEBB 261	Kinematics & Dynamics of Machines	3+1	4	3	0	2	4
2	MEBB 262	Heat and Mass Transfer	3+1	4	3	0	2	4
3	MEBB 263	Engineering Metrology & Instrumentation	2+1	3	2	0	2	3
4	MELB 251	Manufacturing Sciences-II	3	3	3	0	0	3
5	MELB 252	Design of Machine Elements	3	3	3	0	0	3
6	MEPB 271	Programming with MATLAB	1	1	0	0	2	1
7	MEPB 272	Project-II	2	2	0	0	0	2
	Total		**14+6**	**20**	**14**	**0**	**6**	**20**

Course no: **MEBB 261**	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**Yes**	**No**
Type of Course	**Theory**		Core Engineering Course	
Course Title	**Kinematics & Dynamics of Machines**			
Course Coordinator				
Course Objectives:	1. To familiarize the various steps involved in the Design Process 2. To understand the principles involved in evaluating the shape and dimensions of a component to satisfy functional and strength requirements. 3. To learn to use standard practices and standard data 4. To learn to use catalogues and standard machine components (Use of P S G Design Data Book is permitted)			

Course Outcomes (COs)		
	CO-1	Understand basic structure and elements of machines.
	CO-2	Identify functional characteristics of various machine elements.
	CO-3	Synthesize various mechanisms based on position, velocity and acceleration requirements.
	CO-4	Determine position, velocity and acceleration of linkages in mechanism at any instant.
	CO-5	Analyse friction and its practical application in mechanical engineering.

Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	2	4	**48**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	NIL				

Text Books:	
	1. Theory of Machines, Rattan S S, Tata McGraw-Hill 2. Kinematics and Dynamics of Machinery, Norton R L, McGraw-Hill
Reference Books:	

	1. Theory of Machines and Mechanisms, Uicker J J Jr., Pennock G R, Shigley J E, Oxford Press. 2. Mechanism and Machine Theory, Ambekar, A G, Prentice Hall 5. Theory of Machines, Singh Sadhu, Pearson Education
Content	**UNIT - I** **Introduction of Mechanisms and Machines:** Concepts of Kinematics and Dynamics, Mechanisms and Machines, Planar and Spatial Mechanisms, Kinematic Pairs, Kinematic Chains, Kinematic Diagrams, Kinematic Inversion, Four bar chain and Slider Crank Mechanisms and their Inversions, Degrees of Freedom,Mobility and range of movement - Kutzbach and Grubler's criterion, Number Synthesis, Grashof's criterion , straight line mechanisms. **UNIT - II** **Velocity and Acceleration Analysis:** Graphical and analytical velocity analysis of four bar pin jointed linkages and four bar slider crank linkages, Instant centers of velocity, Graphical and analytical acceleration analysis of four bar pin jointed linkages and four bar slider crank linkages, Graphical velocity and acceleration analysis of quick return mechanisms. **UNIT - III** **Graphical and Analytical Linkage Synthesis**: Synthesis, Function, Path, and Motion Generation, Dimensional synthesis (Graphical): Two position synthesis, Three Position synthesis, Coupler curves, Position Analysis : Graphical position analysis of linkages, Algebraic position analysis of linkages, Four bar slider crank position solution, Two position motion generated by analytical synthesis, Three position motion generated by analytical synthesis. **UNIT - IV** **Cams:** Types of cams, Types of followers, Follower displacement programming, Derivatives of follower Motion, Motions of follower, Layout of cam profiles. **Belt, Ropes and Chains:** Types of belt drive, Velocity ratio, Slip, Pulley arrangement, Length of belt, Law of belting, Ratio of friction tension, Power transmitted, Centrifugal effects on belts, Maximum power transmitted, Creep, Chains, Chain length, Angular speed ratio, Classification of chain. **UNIT - V** **Friction, Clutch and Brake:** Introduction to friction, Law of friction, Coefficient of friction, Inclined plane, Pivot and Collars, Friction clutches, Rolling Friction, Types of brakes, Block and Shoe brakes, Differential band brake, Internal expanding shoe brake, Braking effect in vehicle. **Balancing:** Balancing of rotating masses Single and multiple – single and different planes. Balancing of Reciprocating Masses- Primary, Secondary, and higher balancing of reciprocating masses. Analytical and graphical methods **Gyroscope:** Principle of gyroscope, Roll, pitch and Yaw motions, gyroscopic effect in Aeroplanes, Naval ships, Automobiles and two wheelers.

Course Assessment	**Theory (100%):** Continuous Evaluation 25%, Mid Semester 25% End Semester 50% **Laboratory (100%)**: Continuous Evaluation 50%, End Semester 50%

Kinematics & Dynamics of Machines Lab

List of Experiment:

1. Drawing work related to inversion of four bar mechanism and slider and crank mechanism.
2. Drawing work related to velocity and acceleration diagrams of various mechanisms.
3. Drawing work related to cam profile.
4. Drawing work and computation related to synthesis.
5. Computerized Synthesis.
6. Analysis related to belt, rope, and chain drive.
7. Analysis related to brakes, and clutches.
8. Analysis related to gears and gear train.
9. Gyroscope
10. Balancing

List of Major Equipments:

- Drawing hall facility.
- Models of different mechanisms like four bar mechanism, quick return mechanisms, mechanisms with lower pairs and machine elements like belt, pulley, gear, gear train and cams

Course no: MEBB 262	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**Yes**	**No**
Type of Course	**Theory and Practical**		Core Engineering Course	
Course Title	**Heat and Mass Transfer**			
Course Coordinator				
Course objectives:	1. The course has been designed to impart basic understanding of heat and mass transfer mechanisms and to enable the students to apply these in solving real problems. 2. To introduce the thermal analysis and sizing of heat exchangers.			

Course Outcomes (COs)		
	CO-1	Understand various modes of heat transfer and mass transfer
	CO-2	Apply the conduction heat transfer distribution in various applications.
	CO-3	Evaluate the heat transfer distribution in various modes.
	CO-4	Explore the real time applications of radiation mode of heat transfer.
	CO-5	Analyse the performance of heat exchangers.

Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	2	4	**48**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	NIL				

Text Books:	
	1. Fundamental of Heat and Mass Transfer, Incropera and Dewitt, John Wiley & Sons. 2. Heat Transfer A Practical Approach, Cengel, Tata McGraw-Hill 3. Heat Transfer, Holman J.P., Tata McGraw –Hill

Reference Books:	
	1. Heat Transfer, Ozisik, Tata McGraw-Hill 2. Heat Transfer - A Basic Approach, M. Necati Ozisik, McGraw Hill, New York. 3. Heat Transfer, Alan J. Chapman, Macmillan, New York. 4. Heat Transfer, S. P. Sukhatme, Universities Press.
Content	**UNIT - I** **Introduction:** Mode of heat transfer, conduction, convection and radiation. **Conduction Heat Transfer:** Fourier's law, thermal conductivity of matter and other relevant properties, heat diffusion equation, boundary and initial conditions. One –dimensional steady- state conduction through plane wall, cylinder and sphere, conduction with thermal energy generation, Critical Thickness of Insulation, Transient heat conduction, heat transfer from extended surfaces. Two- dimensional steady-state conduction through the plane wall. **UNIT - II** **Convection Heat Transfer:** Application of Dimensional Analysis to Free and Forced Convection, Velocity, thermal and concentration boundary layers and their significance, laminar and turbulent flow, convection transfer equations, boundary layer similarity and normalized convection transfer equations, heat and mass transfer analogy, Reynolds analogy, effect of turbulence, convection in external and internal flow, free convection, boiling and condensation. **UNIT - III** **Radiation Heat Transfer:** Fundamental concepts, radiation intensity and its relation to emission, irradiation and radiosity, blackbody radiation, Wien's displacement law, Stefan Boltzmann's Law, Kirchhoff's Law, Black, Gray and Real Surfaces etc. Radiation exchange between surfaces, blackbody radiation exchange, Concept of View Factor and Shape Factor, radiation exchange between diffuse gray surfaces in an enclosure. **UNIT - IV** **Heat exchangers:** Heat exchangers types, overall heat transfer coefficient, analysis of parallel-flow, counter flow, multi-pass and cross-flow heat exchangers, effectiveness – NTU method, compact heat exchangers. **UNIT - V** **Mass Transfer:** Fick's law of diffusion, mass diffusion equation, boundary and initial conditions, mass diffusion without and with homogeneous chemical reactions, transient diffusion.
Course Assessment	**Theory (100%):** Continuous Evaluation 25%, Mid Semester 25% End Semester 50% **Laboratory (100%):** Continuous Evaluation 50%, End Semester 50%

Heat and Mass Transfer Lab

The objective of this lab is to learn basic modes of heat transfer and implement the knowledge of this subject as an engineering design and analyse of heat transfer. The lab curriculum is designed for 2nd year UG students for Mechanical engineering. At the end of the course students will be able to implement their ideas in various applications and create job opportunities.

List of Experiments

S.No.	Description
1.	To plot temperature distribution and analyse heat transfer through composite wall
2.	To determine thermal conductivity of insulating powder.
3.	To find and compare heat transfer coefficient in natural convection transfer
4.	To find and compare heat transfer coefficient in forced convection transfer
5.	Determination of surface emissivity of a given test plate at a given absolute temperature
6.	To study the inception and growth of Cavitation.
7.	Determination of temperature distribution, efficiency and effectiveness of the fin working in a forced convection environment.
8.	Determination of heat transfer coefficients for parallel flow, counter flow, shell & Tube type heat exchangers etc.
9.	Determination of heat transfer coefficients for Boiling and Condensation Heat Transfer
10.	Thermal conductivity apparatus for Liquids, Nanofluids, Oils, Lubricants, & Coolants.
11.	Calibration apparatus for thermocouple

Course no: **MEPB 263**	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**Yes**	**No**
Type of Course	**Theory & Practical**			
Course Title	**Engineering Metrology & Instrumentation**			
Course Coordinator				
Course Objectives:	1. To impart knowledge about different types of measurement methods 2. To introduce different measuring techniques for identifying behavior of the systems. 3. To understand the different principles of metrology and measurement.			
Course Outcomes (COs)	CO-1	Impart theoretical knowledge of physical processes occurring in Measuring Instruments.		
	CO-2	Express the basic concept of Sensors, Transducers and relate them to other disciplines such as Electrical and electronics etc.		
	CO-3	Familiarize the student with the current research in the field of carbon nanotubes and sensors with characterization and applications.		
	CO-4	To solve the different problems of Limits, Fits, Tolerances and Gauging with Instruments errors.		
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	2	0	2	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	NIL				
Text Books:					

	1. Engineering Metrology and Measurements by N.V. Raghavendra and L.Krishnamurthy, Oxford University Press. 2. Carbon Nanotubes: A New Alternative for Electrochemical Sensors (Nanotechnology Science and Technology) UK ed. Edition. 3. Mechanical Measurements by Backwith, Marangoni and Lienhard Pearson Education.
Reference Books:	
	1. Engineering Metrology by R.K. Jain, Khanna Publisher. 2. A text book of Measurement and Metrology by A.K. Sawhney, and M. Mahajan Dhanpat Rai & Co.
Content	**UNIT - I** **Linear and Angular Measurements**: Linear Measuring Instruments, Angle measuring instruments, Comparators, Calibration of Instruments Interchangeability, Types of fits, Basic-Hole System, Basic-Shaft System, Types of Assemblies, Design of limit gauges, Introduction to GD&T. **UNIT - II** **Strain Measurement:** Strain gauges, Selection and Installation factors, Strain rosettes, ballast circuit, Wheatstone bridge circuit, and Temperature compensation. **Pressure Measurement:** Pressure gauges**,** Pressure transducers, strain gauge pressure cells, measurement of high pressure & low pressures. **Temperature Measurement:** Thermometers, thermocouples, thermistors, pyrometers, Calibration. **Force, Speed and Torque Measurement:** Load Cells, Dynamometers, Tachometer, Stroboscope, measurement of torque of rotating shafts, Seismic instruments: vibrometers and accelerometers. **UNIT - III** **Transducers**: Transducers, Types of Transducers Types, Strain Gages, Displacement Transducers, Instrumentation Amplifier, Isolation Amplifier. **UNIT - IV** **Carbon Nanotubes and other smart sensors:** Advantages, Typical applications. Fabrication process. SWCNT and MWCNT. Application areas of CNT. Principle of operation- Silicon capacitive accelerometer, Piezo-resistive pressure Sensor, Conductometric gas Sensor, Fiber-optic sensors. Electrostatic comb-drive. **UNIT - V** **X-ray basics:** Production of X-ray; The continuous and characteristic spectrum; Absorption; Filters. **Controls:** Introduction, Concept of Automatic Controls; Open loop & closed loop systems; Servo- mechanisms;

Course Assessment	**Theory (100%):** Continuous Evaluation 25%, Mid Semester 25% End Semester 50% **Laboratory (100%):** Continuous Evaluation 25%, End Semester 50%

Engineering Metrology & Instrumentation Lab

List of Experiments

1. Study of different types of gauges (Vernier caliper, Vernier Height gauge, Vernier depth gauge, Micrometer, filler gauge go-nogo gauge, plug gauge, go-nogo snap gauge bourdon tube pressure gauge),
2. Calibrations of linear measuring instruments by using slip gauges and calculation of percentage error.
3. Measurement of included angle of a given specimen using Sine Bar and Clinometers.
4. Measurement of diameter of small size hole using Tool Maker's Microscope.
5. Measurement of pitch diameter of a screw thread by vertical Profile Projector
6. Determination of RPM and Torque of a given motor using RPM Measurement Tutor and calculation of percentage error.
7. Determination of velocity of given velocity transducer (Magnetic sensor UGM3140) using velocity Tutor and calculation of percentage error.
8. Measurement of Temperature of a given sample using Temperature Measurement Tutor and calculation of percentage error.
9. Calibration of pressure gauge using Dead Weight Tester.
10. Measurement of strain of a given metallic strip.

Course no: **MELB 251**	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**Yes**	**No**
Type of Course	**Theory**			
Course Title	**Manufacturing Sciences-II**			
Course Coordinator				
Course objectives:	1. To understand the Physics of the cutting processes and experimental findings of the mechanics of process. 2. To impart knowledge about the various metal removal and layer laminating processes. 3. To introduce the fundamental concepts and mechanics of cutting machining, abrasive machining and erosive machining.			
Course Outcomes (Cos)	CO-1	Develop interrelations among ASA, ORS and NRS systems of tool geometry		
	CO-2	Analyze the cutting forces, and estimate machining times for the machining operations.		
	CO-3	Select cutting fluids, tool materials and coatings for improving tool life and machinability.		
	CO-4	Illustrate the thermal aspects in machining.		
	CO-5	Evaluate the performance of modern machining.		
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	NIL				
Text Books:					

	1. Machining and Machine Tools, A. B. Chattopadhyay, Wiley, 2nd Edition, 2017 2. Fundamentals of metal cutting and machine Tools, B L Juneja and G S Sekhon, New Age International publishers, Revised 2nd Edition, 2017. 3. Serope Kalpakjian, Steven R. Schmid "Manufacturing Engineering and Technology" (4th Edition) Prentice Hall. 4. P.N. Rao "Manufacturing Technology" Revised edition
Reference Books:	
	1. Advanced Manufacturing Processes, V. K. Jain, Allied Publishers Pvt. Ltd, 2002. 2. Manufacturing Science, Amitabha Ghosh and A.K. Mallik, East-West Press, 2nd Edition, 2010 3. Modern Machining Processes, P. C. Pandey and H. S. Shan, TMH, 2017.
Content	**UNIT-I** **Introduction:** Classification of Manufacturing Processes, History of Machining, Scope and Significance of Machining, Geometry of Cutting Tools: Geometry of single-point turning tool: Tool-in hand system, ASA system, Significance of various angles of SPTT, Orthogonal Rake System (ORS), Normal Rake System (NRS), Conversions between ASA and ORS systems. **UNIT -II** **Theory of Metal Cutting**: Mechanics of Machining: Processes: Orthogonal and Oblique cutting, Mechanics of Chip formation: Types of chips, chip-breakers, Chip reduction coefficient, shear angle, shear strain, Built-Up-Edge and its effect in metal cutting, Merchant's analysis of metal cutting process – Various forces, power and specific energy in cutting, Effect of tool geometry on cutting forces and surface finish. **Mechanics of Multipoint Machining processes:** Mechanics of Milling process, Overview of CNC Milling, Mechanics of Grinding Processes. Chip length and Specific energy in Grinding, Grinding wheel wear, Surface Finishing Processes. **UNIT-III** **Thermal aspects in machining**: Sources of heat generation, Effects of temperature, Determination of cutting temperature using analytical and experimental methods, Methods of Controlling Cutting Temperature. **UNIT -IV** **Tool wear, Tool life, Machinability**: Wear Mechanisms, Types of tool wear, Tool Life and Machinability. **Machining Economics:** Economics of Machining, A brief treatment for single pass turning operations, **Cutting Tool Materials:** Desirable Properties of tool materials, Characteristics of Cutting Tool Materials, Indexable inserts, coated tools. **Jigs and fixtures:** Overview, work holding devices.

	UNIT V: **Modern Machining Processes:** An overview of modern machining processes – Classification, Mechanical energy based processes: Ultrasonic, water jet and abrasive jet machining, Electrochemical and Chemical energy based modern machining processes: Electro chemical machining & Chemical machining, Thermal energy based Electric Discharge Machining (sinking EDM and Wire-cut EDM).
Course Assessment	**Theory (100%):** Continuous Evaluation 25%, Mid Semester 25% End Semester 50%

Course no: **MELB 252**	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**Yes**	**No**
Type of Course	**Theory**		Core Engineering Course	
Course Title	**Design of Machine Elements**			
Course Coordinator				
Course Objectives:	1. To familiarize the various steps involved in the Design Process 2. To understand the principles involved in evaluating the shape and dimensions of a component to satisfy functional and strength requirements. 3. To learn to use standard practices and standard data 4. To learn to use catalogues and standard machine components (Use of P S G Design Data Book is permitted)			
Course Outcomes (COs)	CO-1	Explain the influence of steady and variable stresses in machine component design		
	CO-2	Apply the concepts of design to shafts, keys and couplings		
	CO-3	Apply the concepts of design to temporary and permanent joints		
	CO-4	Apply the concepts of design to energy absorbing members, connecting rod and crankshaft		
	CO-5	Apply the concepts of design to bearings.		
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	NIL				
Text Books:					

	1. Bhandari V, "Design of Machine Elements", 4th Edition, Tata McGraw-Hill Book Co, 2016. 2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "Mechanical Engineering Design", 9th Edition, Tata McGraw-Hill, 2011.
Reference Books:	
	1. Machine design an integrated approach, Robert L Norton, Pearson Education, Second edition, 2009. 2. Machine Design, Black and Adams, McGraw Hill and Co, New Delhi, 2002.
Content	**UNIT - I** **Steady stresses and variable stresses in machine members:** Introduction to the design process – factors influencing machine design, selection of materials based on mechanical properties – Preferred numbers, fits and tolerances – Direct, Bending and torsional stress equations – Impact and shock loading – calculation of principle stresses for various load combinations, eccentric loading – curved beams – crane hook and 'C' frame-Factor of safety – theories of failure – Design based on strength and stiffness – stress concentration – Design for variable loading. **UNIT - II** **Shafts and Couplings:** Design of solid and hollow shafts based on strength, rigidity and critical speed – Keys, keyways and splines – Rigid and flexible couplings. **UNIT - III** **Temporary and permanent joints:** Threaded fasteners – Bolted joints including eccentric loading, Knuckle joints, Cotter joints – Welded joints, riveted joints for structures – theory of bonded joints. **UNIT - IV** **Energy storing elements and engine components:** Various types of springs, optimization of helical springs – rubber springs – Flywheels considering stresses in rims and arms for engines and punching machines-Connecting Rods and crank shafts. **UNIT - V** **Bearings:** Sliding contact and rolling contact bearings – Hydrodynamic journal bearings, Somerfield Number, Raimondi and Boyd graphs, — Selection of Rolling Contact bearings. Simple gear drive - Velocity ratio - gear trains - simple gear train - compound gear train - reverted gear train - epicyclic gear train –simple problems on simple and compound gear trains-number of teeth and gears.
Course Assessment	**Theory (100%):** Continuous Evaluation 25%, Mid Semester 25% End Semester 50%

Course no: **MEPB 272**	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**Yes**	**No**
Type of Course	**Training**			
Course Title	**Project- Summer Training**			
Course Coordinator				
Course Objectives:	1. A student may complete the training before the beginning of 5th semester and register for it in 5th semester. The duration of the internship or practical training will be for a minimum of 4 weeks. 2. Related engineering and mathematical fundamentals. 3. Application of the knowledge acquired from the engineering study.			
Course Outcomes (COs)	CO-1	Identification of Industrial/ Academic / Engineering Problem		
	CO-2	To identify and utilize relevant previous work that supports their selected project problem.		
	CO-3	Identification and application of appropriate methodologies to solve the project problem.		
	CO-4	Project report writing.		
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	0	0	0	2	-
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	NIL				

Text Books:	
	As required to complete the project
Reference Books:	
	As required to complete the project
Content	Not required
Course Assessment	Report submission and presentation

SEMESTER – V

Sl. No.	Course Code	Course Name	Credits		L	T	P	C
1	MEBB 311	IC Engines & Gas Turbines	3+1	4	3	0	2	4
2	MEBB 312	Fluid Machinery	3+1	4	3	0	2	4
3	MEBB 313	CAD/CAM	3+1	4	3	0	2	4
4	MEBB 314	Industrial Engineering	3+1	4	3	0	2	4
5	EELB 311	Control Systems & Engineering	3	3	3	0	0	3
6	MEPB 321	Summer Training-II	1	1	0	0	0	1
	Total		**15+5**	**20**	**15**	**0**	**8**	**20**

Course no: MEBB 311	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**Yes**	**No**
Type of Course	**Theory and Practical**		Core Engineering Course	
Course Title	**Internal Combustion Engines and Gas Turbines**			
Course Coordinator				
Course objectives:	The course has been designed to impart basic understanding of IC engines/Gas Turbines and their mechanisms to enable the students to apply these in solving real problems. To understand combustion and performance analysis of an IC Engine and their emissions.			
Course Outcomes (COs)	CO-1	Understand the working of IC Engines and their applications		
	CO-2	Understand the combustion phenomena in IC Engines		
	CO-3	Understand and Identify the various systems (Ignition/Injection/Cooling/Lubricating) of an IC engines		
	CO-4	Analyze the Performance characteristics of IC Engines & Gas Turbine and their emissions.		
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	2	4	**48**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					

Overlap course codes as per proposed course numbers	NIL				
Text Books:					
	1. Internal Combustion Engines by Ganesan V, TMH 2. Internal Combustion Engines by Mathur& Sharma, DhanpatRai.				
Reference Books:					
	• Internal Combustion Engines by Obert E.F. • Internal Combustion Engines by Gill, Smith & Zuriys, IBH. • Internal Combustion Engine Fundamentals by John B Heywood TMH.				

Content	
	UNIT - I **Introduction:** IC Engines, Components, classification, four stroke and two stroke I.C. Engines, Comparison, Valve timings diagrams. **Thermodynamic analysis of Engine Cycles:** Air standard cycles, Otto cycle, Diesel cycle, Dual cycle, comparison, Air standard efficiency, specific work output, work ratio & mean effective pressure, and other performance parameters, actual cycle from ideal cycle. **UNIT - II** **Combustion in I.C. Engines:** Combustion in SI engines, Ignition Limits, stages of combustion, Ignition Lag and flame-propagation, abnormal combustion, Detonation, Pre-ignition, Octane rating of fuels, SI engine combustion chambers, Combustion in CI engine, stages of combustion, Delay period, Diesel knock, Cetane rating, CI engine combustion chambers. **UNIT - III** **Fuel Supply Systems:** Properties of air-petrol mixtures, Mixture requirements, Carburetors, A/F ratio, Injection systems: requirements, types, Fuel pump, Nozzle, Atomization, **Ignition, Lubrication and Cooling systems:** types, ignition timing, spark plug, Lubrications systems, Properties of lubricating oil, Cooling systems **UNIT - IV** **Engine Testing & Performance:** Performance parameters, BHP, IHP, Mechanical efficiency, BMEP, IMEP, torque, volumetric efficiency BSFC and ISFC , thermal efficiency, Heat balance, Basic engine measurements: fuel and air consumption, brake power, indicated power and friction power, performance curves. **Emission and Pollution:** S. I. Engine and C. I. Engine emissions and its control and comparison. Effect of pollution on Human health and biosphere, Alternative fuels, current scenario on the pollution front. **UNIT - V** **Gas Turbine:** Introduction, components of a gas turbine, open and closed type, Brayton cycle, optimum pressure ratio, effect of operating variables on thermal efficiency, Effect of inter cooling, Reheating, Regeneration, Applications of gas turbines.

Course Assessment	**Theory (100%):** Continuous Evaluation 25%, Mid Semester 25% End Semester 50% **Laboratory (100%):** Continuous Evaluation 50%, End Semester 50%

IC Engine and Gas Turbine Laboratory

List of Experiment

1. Study of 4 Stroke Diesel Engine Sectional Actual Working Model.
    a. Study of 4 Stroke 4 Cylinder Diesel Engine - Motor Driven Actual Cut Section Working Model
    b. Study of Fuel Supply System of a Diesel Engine - Actual Working Model
2. Study of 2 Stroke Petrol Engine - Sectional Working Model
    a. Study of 4 Stroke Petrol Engine - Sectional Working Model
    b. Study of 2 Stroke Diesel Engine - Sectional Working Model
    c. Study of Gas Turbines or Turbojet Engine Model
    d. Multi-Fuel Variable Compression Ratio Common Rail Direct Injection (VCR CRDI) Engine Equipped with Open Electronic Control Unit (ECU) System (Nos. 1) & Emission Measuring Unit
3. CRDI and TDI/PFI with Open ECU Mapping and Controlled EGR (variable and constant speed mode)
    a. Performance optimization with ECU system
    b. Tests at different CR and EGR conditions
4. Single fuel, secondary fuel, Multi-fuel engine characteristics study
5. Combustion analysis like Mass fraction burnt (MFB), Nett heat release (NHR/CHR), rate of pressure raise (RPR), Mean Gas temp (MGT) plots & tabulated data, combustion duration, ignition delay

Course no: MEBB 312	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	**No**	**Yes**	**No**
Type of Course	**Theory and Practical**		Core Engineering Course	
Course Title	**Fluid Machinery**			
Course Coordinator				
Course objectives:	The course has been designed to impart basic understanding of working principles of hydraulic systems which enable the students for applying and solving real problems. To understand performance analysis of various fluid machines and their components.			
Course Outcomes (COs)	CO-1	Understand the impact of jet on various blades of fluid machines.		
	CO-2	Understand the working principles of various fluid machines and their applications		
	CO-3	Analyze the performance of hydraulic turbines and pumps		
	CO-4	Understand the working principles of various hydraulic devices and their applications		
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	2	4	**48**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					

Overlap course codes as per proposed course numbers	NIL				
Text Books:					
	• Hydraulic Machines by K Subramanya, Tata McGraw Hill. • Hydraulic Machines by Jagdish Lal, Metropolitan book co. pvt ltd. • Introduction to fluid mechanics and machines by SK SOM, G Biswas and S Chakrborty, Tata McGraw Hills				
Reference Books:					
	• Fluid Mechanics and Fluid Power Engineering by D S Kumar, S K Kataria& Sons • Fluid Mechanics and hydraulic machines by Modi& Seth, Standard Book House • Fundamentals of Turbomachinery by Venkanna B.K., PHI				

Content	**UNIT - I** **Introduction:** Impulse of Jet and Impulse Turbines: Classification of Fluid Machines & Devices, Application of momentum and moment of momentum equation to flow through hydraulic machinery, Euler's fundamental equation. Introduction to hydrodynamic thrust of jet on a fixed and moving surface (flat &curve), Classification of turbines, Impulse turbines, Constructional details, Velocity triangles, Power and efficiency calculations, Pelton Turbine. **UNIT - II** **Reaction Turbines:** Francis and Kaplan turbines, Constructional details, Velocity triangles, Power and efficiency calculations, Degree of reaction, Draft tube, Cavitations in turbines, Principles of similarity, Unit and specific speed, Performance characteristics, Selection of water turbines. **UNIT - III** **Centrifugal Pumps:** Classifications of centrifugal pumps, Vector diagram, Work done by impellor, Efficiencies of centrifugal pumps, Specific speed, Cavitations & separation, Performance characteristics. **UNIT - IV** **Positive Displacement Pumps**: Reciprocating pump theory, Slip, Indicator diagram, Effect of acceleration, air vessels, Comparison of centrifugal and reciprocating pumps, Performance characteristics. **UNIT - V** **Hydraulic Devices:** Hydraulic accumulator, Hydraulic intensifier, Hydraulic Press, hydraulic crane, hydraulic lift, hydraulic Ram, hydraulic coupling, hydraulic torque converter, air lift pump, jet pump.
Course Assessment	**Theory (100%):** Continuous Evaluation 25%, Mid Semester 25% End Semester 50% **Laboratory (100%):** Continuous Evaluation 50%, End Semester 50%

Fluid Machinery Laboratory

List of Experiments

1. **Performance characteristics of Pelton wheel turbine**

OBJECTIVES: The main objective of pelton turbine is to convert the hydraulic energy to mechanical energy and mechanical energy to electrical energy.

OUTCOMES: The performance characteristics of Pelton wheel turbine under constant head and constant speed is found. The output power, input power and efficiency are found.

2. **Performance characteristics of Francis turbine**

OBJECTIVES: The working fluid changes pressure as it moves through the turbine, giving up its energy. Head on the turbine is determined.

OUTCOMES: The performance characteristics of Francis turbine under constant head and constant speed are found. The output power, input power and efficiency are found.

3. **Performance characteristics of Kaplan turbine**

OBJECTIVES: The main objective of kaplan turbine is to convert the hydraulic energy to mechanical energy and mechanical energy to electrical energy.

OUTCOMES: The performance characteristics of Kaplan turbine is found. The output power, input power and efficiency are found.

4. **Performance of characteristics of a centrifugal pump**.

OBJECTIVES: The main objective of pumps is that it changes electrical energy to mechanical energy and mechanical energy to hydraulic energy.

OUTCOMES: Various tests on centrifugal pumps are done at various heads. The output power, input power and efficiency are found.

5. **Performance of characteristics of a reciprocating pump**

OBJECTIVES: The main objective of pumps is that it changes electrical energy to mechanical energy and mechanical energy to hydraulic energy.

OUTCOMES: Various tests on reciprocating pump are done at various heads. The output power, input power and efficiency are found.

Course no: **MEBB 313**	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**Yes**	**No**
Type of Course	**Theory**		Elective	
Course Title	**CAD/CAM**			
Course Coordinator				
Course Objectives:	To familiarize the various steps involved in the Design Process To study about the CAD process and concept of geometric modeling To study the concepts of wireframe modeling To study the concepts related to surface modeling To study the concepts of solid modeling To study about geometric transformations techniques, data exchange formats and mechanical tolerance To impart the students the basic and essential concepts in using Computer Assisted Manufacturing (CAM) and Computer Numerical Control (CNC) machines.			
Course Outcomes (COs)	CO-1	Understand the CAD process and geometric modeling concepts		
	CO-2	Understand the concepts of surface modeling and application of wire frame modeling		
	CO-3	Understand and apply the concepts of solid modeling techniques		
	CO-4	Understand and apply the concepts of solid modeling techniques		
	CO-5	Learn the basic concepts of manufacturing planning and control and hands on experience in using CAM software to design, simulate and write CNC programs		

Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	2	4	48

Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	NIL				
Text Books:					
	1. Mikell P. Groover and Emory W. Zimmers ,CAD/CAM: Computer Aided Design Manufacturing, Prentice Hall, 1996. 2. Chris Macmahon and Jimmie Browne CADCAM: principles, practice and manufacturing management, 2nd edition, Addison Wesley, 1998. 3. P. Radhakrishnan, S. Subramanyan, and V. Raju, CAD/CAM/CIM , 2nd edition, New Age, 2000. 4. P.N. Rao, CAD/CAM: Principles and Applications" 5. Ibrahim Zeid "Mastering CAD/CAM, 2nd edition, McGraw Hill Education				
Reference Books:					
	1. Kunwoo Lee, Principles of CAD/CAM/CAE systems, Addison Wesley, 1999. 2. Mark E. Coticchia, George W. Crawford, and Edward J. Preston, CAD/CAM/CAE systems: justification, implementation and productivity measurement, 2nd edition, New York, Marcel Dekker, 1993.				

Content	**UNIT - I** **CAD Tools**: Definition of CAD Tools, Graphics standards, Graphics software, requirements of graphics software, Functional areas of CAD, Efficient use of CAD software. Basics of Geometric Modelling: Requirement of geometric 3D Modeling, Geometric models, Geometric construction methods, Modelling facilities desired. **UNIT- II** Classification of wireframe entities, Curve representation methods, and Parametric representation of analytic curves: line, circle, arc, conics, Parametric representation of synthetic curves: Hermite cubic curve, Bezier curve, B-Spline curve wire, NURBS, Curve manipulations. Surface Modeling: Classification of surface entities, Surface representation methods, Parametric representation of analytic surfaces: plane surface, ruled surface, surface of revolution, tabulated cylinder, **UNIT III** Solid Modeling: Geometry and topology, Boundary representation, Euler operators, Constructive solid geometry: CSG primitives, Boolean operators, CSG expressions, Interior, Exterior, closure, Sweeping: linear and non-linear, Solid manipulations, feature modeling. Transformations: 2-D and 3-D transformations: translation, scaling, rotation, reflection, concatenation, homogeneous coordinates, Perspective projection, orthotropic projection, isometric projection, Hidden surface removal, shading, rendering. Evaluation Criteria: Evaluation criteria of CAD software. **UNIT IV** **NC and CNC Technology**: Types, Classification, Specification and components, Construction Details, Controllers, Sensors and Actuators, CNC hardware: Re circulating ball screw, anti friction slides, step/servo motors. Axis designation, NC/CNC tooling. Fundamentals of Part programming, Types of format, Part Programming for drilling, lathe and milling machine operations, subroutines, do loops, canned Cycles, parametric subroutines. **UNIT V.** Flexible Manufacturing System, Automated material handling system, Automated Storage and Retrieval System, Automated Guided Vehicles, Cellular manufacturing, Tool Management, Tool supply system, Introduction to PPC, ERP, Just in Time philosophy, GT applied to FMS, concepts of Expert System in Manufacturing and Management Information System.

Course Assessment	**Theory (100%):** Continuous Evaluation 25%, Mid Semester 25% End Semester 50%. **Laboratory (100%):** Continuous Evaluation 50%, End Semester 50%.

Course no: **MEBB 314**	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**Yes**	**No**
Type of Course	**Theory**		Core Engineering	
Course Title	**Industrial Engineering**			
Course Coordinator				
Course Objectives:	The objective of this course is to understand the evolution of industrial engineering.			
Course Outcomes (COs)	CO-1	To understand the basic concepts of industrial engineering.		
	CO-2	To estimate the basic work content in a specific job and to calculate the standard time.		
	CO-3	To apply the fundamentals of materials management in industrial engineering.		
	CO-4	To analyze the appropriate wage and incentive plan for the employees of an organization.		
	CO-5	To develop the work place for equipment and man machine systems.		

Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	NIL				
Text Books: Text Book:					

	1. Telsang M. T. , Industrial Engineering and Production Management, 3rd Edition, S. Chand Pub;lication, INDIA. 2. Barnes R. M., Motion & Time Study: Design and measurement of Work, 7th ed., John Wiley and Sons, New York, USA. 3. P. Gopalkrishnan and M. Sundaresan- Materials Management: Integrated Approach, Prentice Hall, New Delhi. 4. Jhamb L.C. "Work Study and Ergonomics", Everest Publishing House, Pune,India.
Reference Books:	
	1. Salvendy, G., "Hand Book of Industrial Engineering: Technology and Management", 3rd ed., John Wiley and Sons, New York, USA. 2. B. Mahadevan , Operations Management, Himalaya publications, India. 3. Norman Gaither , Operations Management, Cengage publications, India. 4. Maynard, H.B. and Zandin, K., Industrial Engineering Hand Book, 5th ed., McGraw Hill Book Company, New York, USA.

Content	**UNIT - I** **Introduction**: History of development of Industrial Engineering, work of Taylor and Gilberth, Modern Industrial Engineering. Productivity: Productivity & Standard of living, productivity in individual enterprise, Reducing work content and ineffective time. **UNIT II** **Method Study:** Definition, Objectives and procedures, Selection of job, various recording techniques like outline process charts, Flow process charts, Man machine charts etc. **Time Study:** Calculation of Standard time, Work Sampling: Basic procedure, Design of work sampling study, conducting work sampling study and establishment of standard time. Predetermined Motion time systems, MTM, Work factors system and other standard data systems MOST. **UNIT III** **Inventory Management**: Purchasing - Objectives, significance, policies and methods. Stores - Objective, Policies, and procedures etc. MRP and Inventory control: Introduction to MRP, Types of inventory control, E.O.Q. model, Selective inventory control, JIT and KANBAN concepts. **UNIT IV** **Production Planning & Control (PPC):** Forecasting techniques, Aggregate planning, Capacity planning, and Quality Control. **Wage Incentives**: Measured day work and wage incentives and Productivity, different types of wage incentive plans. **UNIT V** **Introduction to Ergonomics:** Ergonomics as a multidisciplinary field, components. Importance of ergonomics in equipment and work-design. Concept of man-machine system; Types and characteristics of Man-machine systems.
Course Assessment	**Theory (100%):** Continuous Evaluation 25%, Mid Semester 25% End Semester 50% **Laboratory (100%):** Continuous Evaluation 50%, End Semester 50%.

LIST OF EXPERIMENTS:

1. To study various kind of stopwatches.
2. To measure elemental time for a cyclic activity with the help of different stopwatches
3. to find the time required to fill the board with the pins under different conditions
4. PIN Board study (Two board)
5. To assess job difficulty in putting the pins through cup and cone arrangement on an inclined plane.
6. Assessment of performance rating by dealing card.
7. Assessment of performance rating by walking distance (speed rating).
8. To do method study on an assembly operation of bulb holders.
9. To forecast the industrial demand.
10. To conduct the finger dexterity test

Course no: **EELB 311**	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**Yes**	**No**
Type of Course	**Theory**		Allied Engineering	
Course Title	**Control Systems & Engineering**			
Course Coordinator				
Course objectives:				
Course Outcomes (COs)	CO-1	To understand different types of control systems		
	CO-2	Application of differential equations and transfer functions in various electrical and mechanical systems		
	CO-3	Control systems in flywheel and various mechanical systems using MATLAB		
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**

Text Books:

1. K. Ogata. Modern Control Engineering (current edition). Prentice-Hall India
2. I.J. Nagrath, Madan Gopal. Control Systems Engineering. New Age Publishers

Reference Books:

1. G. F. Franklin, J. D. Powell, and A. Emami-Naeini. Feedback Control of Dynamic Systems (current edition). Pearson Education.
2. F. Golnaraghi and B. C. Kuo. Automatic Control Systems. Wiley.

Content	**UNIT - I** Introduction to control systems, Open loop and closed loop control systems and their differences, Classification of control systems, Feedback Characteristics, Effects of positive and negative feedback. **UNIT - II** Introduction from the physical model to the ordinary differential equation (ODE), 1st and 2nd order system behavior (from the ODE), Translation and rotational mechanical system (in the flywheel). **UNIT - III** Laplace transform, solving ODEs, Transfer functions, poles, zeros, Observation of behavior based on transfer functions in the flywheel, Electrical elements R, L, C, op-amp, The DC motor and its dynamics, 1st and 2nd order system characteristics: theory, 1st and 2nd order systems: observation on the flywheel, Feedback TF, MATLAB© LTI, and SISO tools. **UNIT - IV** Root locus (concept and observation), Drawing root locus (part I: theory), Drawing root locus (part II: MATLAB and flywheel), P control-flywheel modeling, P control on the flywheel-effect of gain, PI control on the flywheel-steady state error. **UNIT- V** Practice on root locus and P-control, PID control: speeding up and stabilization, Control of an Inverted pendulum.
Course Assessment	**Theory (100%):** Continuous Evaluation 25%, Mid Semester 25% End Semester 50%.

SEMESTER – VI

Sl. No.	Course Code	Course Name	Credits		L	T	P	C
1	MELB 351	Optimization & Simulation in Engineering Applications	3	3	3	0	0	3
2	MEBB 361	Manufacturing Automation & Robotics	3+1	4	3	0	2	4
3	MEBB 362	Mechatronics Engineering	3+1	4	3	0	0	4
4	MEBB 363	Heating, Ventilation & Air conditioning (HVAC)	3+1	4	3	0	2	4
5	MELB 38X	Program Elective-1	3	3	2	0	0	3
6	MEPB 371	Project-III	2	2	0	0	0	2
	Total		**15+5**	**20**	**15**	**0**	**4**	**20**

NOTE: Summer Training (6 - 8 Weeks) is mandatory for each student to continue the program and their evaluation will be done in the Semester-VII.

Course no: **MELB 351**	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**Yes**	**No**
Type of Course	**Theory**		Core	
Course Title	**Optimization & Simulation in Engineering Applications**			
Course Coordinator				
Course Objectives:	The aim of the course is to provide basic knowledge of optimization theory and methods of simulations, as well as develop skills in modelling and solving problems in the appropriate field of technology using efficient algorithms and simulations.			
Course Outcomes (COs)	CO-1	Illustrate the use of fundamental laws to develop model for Chemical engineering processes.		
	CO-2	Outline the scope of process optimization and its applications to chemical processes.		
	CO-3	Apply mathematical principles and techniques to solve the models for simulation		
	CO-4	Analyse process plant simulation results using professional simulators.		
	CO-5	Develop a report that describes the model and the solving technique, analyse the results and propose recommendations in language understandable to the decision-making processes in Management Engineering.		
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					

Overlap course codes as per proposed course numbers	NIL				
Text Books:					
	1. Prem Kumar Gupta, D. S. Hira: Operations Research. S. Chand,				
Reference Books:					
	1. B Wayne Bequette, Process Dynamics: Modeling, Analysis and Simulation, Prentice Hall International Inc. 2. B V Babu, Process Plant Simulations, Gulf Publications. 3. William L. Luyben, Process Modeling, Simulation and Control for Chemical Engineers, McGraw Hill International Editions.				

Content	**UNIT – I** **Introduction:** Definition of Modelling, Simulation and Optimization with their importance, Scope and applications. Concept of System and environment, Continuous and discrete systems, Linear and non-linear systems, Static and Dynamic models, Principles of modeling, Basic Simulation modeling, Role of simulation in model evaluation and studies, advantages of simulation. Mathematical **UNIT – II** **Modelling Aspects:** Definition of model, classification of models, process model, deterministic and stochastic process, process to build a model, degrees of freedom analysis for model, empirical model, selecting functions to fit empirical data, Black-box model. **UNIT – III** **Basic Concepts of Optimization:** Scope and hierarchy of optimization, examples of applications of optimization, the essential features of optimization problems, general procedure for solving optimization problems, obstacles to optimization, continuity of function, convexity and its applications, interpretation of the objective function in terms of its quadratic approximation, necessary and sufficient conditions for an extremum of an unconstrained function. **UNIT –IV** **Linear Programming (LP) :** Concepts, Formulation of model, Graphical solution, Maximization / Minimization – Simplex Algorithm, Use of slack / surplus / artificial variables, Big M and Two phase method – Nature & type of solutions, Interpretation of optimal solution. Dual problem – relation between primal and dual, Dual simplex method – Interpretation of dual variables, Introduction to Integer programming, Economic Interpretation. **UNIT –V** **Transportation & Assignment Problems**: Concepts, formulations of models, Solution procedures, Optimality checks, Balanced/Unbalanced, Maximum/Minimum problems, Prohibited case – degeneracy. **Project Management:** Introduction to PERT and CPM, critical Path calculation, float calculation and its importance. Cost reduction by Crashing of activity.

Course Assessment	**Theory (100%):** Continuous Evaluation 25%, Mid Semester 25% End Semester 50%

<table>
<tr><td>Course no:
MEBB 361</td><td colspan="2">Open course (YES/NO)</td><td>HM Course (Y/N)</td><td colspan="2">DC (Y/N)</td><td>DE (Y/N)</td></tr>
<tr><td></td><td colspan="2">No</td><td>No</td><td colspan="2">Yes</td><td>No</td></tr>
<tr><td>Type of Course</td><td colspan="2">Theory</td><td></td><td colspan="2">Core Engineering</td><td></td></tr>
<tr><td>Course Title</td><td colspan="6">Manufacturing Automation & Robotics</td></tr>
<tr><td>Course Coordinator</td><td colspan="6"></td></tr>
<tr><td>Course objectives:</td><td colspan="6"></td></tr>
<tr><td rowspan="4">Course Outcomes (COs)</td><td>CO-1</td><td colspan="5">To study automation in manufacturing and production system</td></tr>
<tr><td>CO-2</td><td colspan="5">Material handling using automation</td></tr>
<tr><td>CO-3</td><td colspan="5">To study basics of robotics</td></tr>
<tr><td>CO-4</td><td colspan="5">Sensors application in robotics</td></tr>
<tr><td>Semester</td><td colspan="3">Autumn:</td><td colspan="3">Spring:</td></tr>
<tr><td></td><td colspan="2">Lecture</td><td>Tutorial</td><td>Practical</td><td>Credits</td><td>Total Teaching Hours</td></tr>
<tr><td>Contact Hours</td><td colspan="2">3</td><td>0</td><td>1</td><td>4</td><td>36+24</td></tr>
<tr><td colspan="7">Text Books:</td></tr>
<tr><td></td><td colspan="6">1. Automation, Production Systems and Computer Integrated Manufacturing
2. M. P. Grover, Pearson Education.
3. K.S Fu, R.C. Gonzalez, C.S.G. Lee, Robotics, McGraw Hill, 1987.
4. R.K. Mittal & I.J. Nagrath, “Robotics & Control” TMH-2007</td></tr>
<tr><td colspan="7">Reference Books:</td></tr>
<tr><td></td><td colspan="6">1. Y. Koren, Robotics for Engineers, McGraw Hill, 1985.
2. An Introduction to Automated Process Planning Systems – Tiess Chiu Chang & Richard A. Wysk.</td></tr>
</table>

Content	**Unit I** Introduction: Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations. Production Economics. Detroit-Type Automation: Automated Flow lines, Methods of Work part Transport, Transfer Mechanism, and Buffer Storage. **Unit II** Material handling and Identification Technologies: The material handling function, Types of Material Handling Equipment, Analysis for Material Handling Systems, Design of the System, Conveyor Systems, Automated Guided Vehicle Systems. Automated Storage Systems: Storage System Performance, Automated Storage/Retrieval Systems, Work-in-process Storage, Product identification system: Barcode, RFID etc. **Unit III** Automated Assembly Systems: Design for Automated Assembly, Types of Automated Assembly Systems. Different control technologies in automation: **Unit IV** Fundamentals of robotics. Introduction, construction and applications. The robot and its peripherals: Control systems and components, robot specifications, robot motion analysis and control, end effectors, feedback systems, encoders kinematics, homogeneous coordinates solution of the inverse kinematic problem, multiple solutions. **Unit V** Sensors in Robotics, sensory control Vision. Programming Language: Industrial robot programming languages. Mobile robots. Robot programming environment. Robot applications: Application of robots in surgery, Manufacturing industries, space and underwater. Humanoid robots, Micro robots, Social issues and Future of robotics.
Course Assessment	**Theory (100%):** Continuous Evaluation 25%, Mid Semester 25% End Semester 50% **Practical (100%):** Continuous Evaluation 50%, End Semester 50% **Total:** Theory 60% + Practical 40%

List of Experiments:

1. Speed Control circuits for double acting cylinder
2. A synchronization circuit for two cylinders
3. Continuous reciprocation of the double acting cylinder
4. Sequencing of two cylinder circuits
5. Cascading circuit for trapped signals-2 groups
6. Cascading circuit for trapped signals- 3 groups
7. Process Control using Virtual Instrumentation
8. Run A Stepper Motor: For Required Angle
9. Characteristics of Inductive, capacitive and photoelectric proximity sensors
10. Pick and place operation of ABB Robot in Manual Mode
11. Pick and place operation of ABB Robot in Teach Pendant method

<table>
<tr><td>Course no:
MEBB 362</td><td colspan="2">Open course (YES/NO)</td><td>HM Course (Y/N)</td><td colspan="2">DC (Y/N)</td><td>DE (Y/N)</td></tr>
<tr><td></td><td colspan="2">No</td><td>No</td><td colspan="2">Yes</td><td>No</td></tr>
<tr><td>Type of Course</td><td colspan="2">Theory</td><td></td><td colspan="2">Core Engineering</td><td></td></tr>
<tr><td>Course Title</td><td colspan="6">Mechatronics Engineering</td></tr>
<tr><td>Course Coordinator</td><td colspan="6"></td></tr>
<tr><td>Course objectives:</td><td colspan="6"></td></tr>
<tr><td rowspan="4">Course Outcomes (COs)</td><td>CO-1</td><td colspan="5">To study fundamentals of mechatronics</td></tr>
<tr><td>CO-2</td><td colspan="5">Elements of mechatronic system design</td></tr>
<tr><td>CO-3</td><td colspan="5">To understand simulation technics used in mechatronic system design</td></tr>
<tr><td>CO-4</td><td colspan="5">Automation application</td></tr>
<tr><td>Semester</td><td colspan="2">Autumn:</td><td colspan="4">Spring:</td></tr>
<tr><td></td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Credits</td><td colspan="2">Total Teaching Hours</td></tr>
<tr><td>Contact Hours</td><td>3</td><td>0</td><td>1</td><td>4</td><td colspan="2">36+24</td></tr>
<tr><td colspan="7">Text Books:</td></tr>
<tr><td></td><td colspan="6">• Devadas Shetty, Richard A.Kolkm, “Mechatronics system design, PWS publishing company, 2009.
• Bolton, “Mechatronics – Electronic control systems in mechanical and electrical engineering, 2nd edition, Addison Wesley Longman Ltd., 2009.</td></tr>
<tr><td colspan="7">Reference Books:</td></tr>
<tr><td></td><td colspan="6">• Brian morriss, “Automated manufacturing Systems – Actuators Controls, sensors and Robotics”, McGraw Hill International Edition, 2000.
• Bradley, D. Dawson, N.C.Burd and A.J. Loader, “Mechatronics: Electronics in product and process”, Chapman and Hall, London, 1999.</td></tr>
</table>

Content	**Unit I** Mechatronic systems, Key elements, Mechatronic design process, Application types, Interfacing issues, Man Machine Interfaces, Safety features, optimization of Mechatronic design, Fault diagnosis. **Unit II** Introduction to Hydraulic and Pneumatic Systems. Basic Components. Mechatronics & Electro-hydraulics devices in Fluid Power, Hybrid Hydro-Mechanical Systems, Fundamentals of compressible fluid flow & pneumatic device. Application of Hydraulics & Pneumatics in industrial Automation,Special topics on Hydraulics & Pneumatics. **Unit III** Mathematical models, Block diagram modelling, Analogy approach, Impedance diagrams, Models for Electrical, Mechanical, Electro-mechanical and Fluid systems, System Identification, Least square method, Closed loop identification, joint input/output identification, State estimators, Model Validation. **Unit IV** Simulation basics, Probability concepts in simulation, Discrete event simulation, Simulation Methodology, Queuing system model components, Continuous system modeling, Monte Carlo simulation, Analysis of simulation results, Simulation life cycle. **Unit V** Microcontrollers, Sensors, Programmable logic controller (PLC), Mass-Spring-Oscillation and Damping system, Position Control of Permanent magnet DC motor using Hall sensor and optical encoder, Auto-control system for Green House Temperature, Solenoid Force-Displacement Calibration system. **Unit VI** Automatic Washing Machine, Hard Drive control, Auto-focusing in Digital Cameras, Active suspension in vehicles, Visual Servoing models, Thermal cycle fatigue of a Ceramic plate, pH Control system, De-icing temperature control system, Skip control of a CD player, Simulation of Rocket thrust control, Time delay Blower.
Course Assessment	**Theory (100%):** Continuous Evaluation 25%, Mid Semester 25% End Semester 50% **Practical (100%):** Continuous Evaluation 50%, End Semester 50% **Total:** Theory 60% + Practical 40%

List of Experiments:

1. Pneumatic Basic Logic Circuits.
2. Pneumatic Circuit for Material Handling System.
3. Electro pneumatic circuit using Relay, Limit Switch and solenoid Valves.
4. Electro-pneumatic circuit for an Automation of Double Acting Cylinder by using proximity Sensors and Cascade System of sequence A+B+ C+ A-B-C-
5. Electro –Hydraulic circuit using proximity Sensors
6. PLC controlled pneumatic Logic circuits
7. PLC controlled pneumatic circuit for Material Handling system.
8. Programming for interfacing of sensors.

Course no: MEBB 363	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**Yes**	**No**
Type of Course	**Theory and Practical**		Core Engineering Course	
Course Title	**Heating, Ventilation & Air conditioning (HVAC)**			
Course Coordinator				
Course objectives:	The course has been designed to impart basic understanding of Heating, ventilation and Air- conditioning (HVAC) systems and their working principles which enable the students for applying these in solving real problems. To understand performance analysis of HVAC system and and their emissions.			
Course Outcomes (COs)	CO-1	Understand the working Principles of HVAC system (Refrigeration and Air conditioning) and Absorption systems		
	CO-2	Analyze the performance of HVAC and Absorption systems		
	CO-3	Calculate the cooling load for air-conditioning system used for various applications		
	CO-4	Operate and analyze the Refrigeration and Air conditioning systems components		

Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	2	4	**48**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					

Overlap course codes as per proposed course numbers	NIL				
Text Books:					
	1. Refrigeration and Air Conditioning - C.P. Arora, Tata McGraw-Hill 2. Basic Refrigeration and Air Conditioning- Ananthana and Rayana McGraw-Hill				
Reference Books:					
	1. Refrigeration and Air Conditioning- Arora and Domkundwar, Dhanpat Rai. 2. Refrigeration and Air Conditioning by Stoecker, McGraw Hill				

Content	
	UNIT - I **Introduction:** Refrigeration, Refrigeration system, Methods of refrigeration, Carnot refrigeration cycle, Unit of refrigeration, Refrigeration effect & C.O.P. Air Refrigeration cycle: Open and closed air refrigeration cycles, Reversed Carnot cycle, Bell Coleman or Reversed Joule air refrigeration cycle, Aircraft refrigeration system, Classification of aircraft refrigeration system. Boot strap refrigeration, Regenerative, Reduced ambient, Dry air rated temperature (DART). **UNIT - II** **Vapour Compression System:** Single stage system, Analysis of vapor compression cycle, Use of T-S and P-H charts, Effect of change in suction and discharge pressures on C.O.P, Effect of sub cooling of condensate & superheating of refrigerant vapor on C.O.P of the cycle, Actual vapor compression refrigeration cycle, Multistage vapor compression system requirement, Removal of flash gas, Intercooling, Different configuration of multistage system, Cascade system. **UNIT - III** **Vapour Absorption system:** Working Principal, Comparison between absorption & compression systems, Elementary idea of refrigerant absorbent mixtures, Temperature – concentration diagram & Enthalpy – concentration diagram , Adiabatic mixing of two streams, Ammonia – Water vapour absorption system, Lithium- Bromide water vapour absorption system, Comparison. Three fluid systems. **UNIT - IV** **Air Conditioning**: Introduction, Psychometric properties, Psychometric chart, Psychometric processes, Thermal analysis of human body, Effective temperature and comfort chart, Cooling and heating load calculations, Inside & Outside design conditions, Heat transfer through walls & roofs, Infiltration & ventilation, Internal heat gain, Sensible heat factor (SHF), By pass factor, Grand Sensible heat factor (GSHF), Apparatus dew point (ADP). Air Washers, Cooling towers & humidifying efficiency. **UNIT – V** **Refrigeration and Air conditioning System Components**: Compressors, condensers, evaporators & expansion devices, Working Principles, Classifications, Transmission and distribution of air through ducts and fans, Filters, Blowers and Heat Pumps. **Refrigerants:** Classification of refrigerants, Nomenclature, Desirable properties of refrigerants, Common refrigerants, Secondary refrigerants and CFC free refrigerants. Ozone layer depletion and global warming considerations of refrigerants.

Course Assessment	**Theory (100%):** Continuous Evaluation 25%, Mid Semester 25% End Semester 50% **Laboratory (100%):** Continuous Evaluation 50%, End Semester 50%

HVAC (Heating, Ventilation and Air-Conditioning) Laboratory

List of Experiments

1. To study refrigeration cycle, determine of coefficient of performance of cycle & determine of tonnage capacity of refrigeration unit.
2. To determine the COP and tonnage capacity of the chilling plant.
3. To determine COP and tonnage capacity of a Air conditioning system.
4. To determine the COP and tonnage capacity of a Mechanical Heat Pump.
5. To determine the COP and tonnage capacity of an Ice plant.
6. To study the cut sectional model of reciprocating, rotary and centrifugal compressor.
7. To study various controls used in Refrigeration and Air-conditioning system.
8. To study different psychometric process & chart.
9. To study works principle of steam jet refrigeration system.
10. To study the analysis of simple vapour compression cycle and explain the types of vapour compression cycle with T-S and P-H diagram.
11. To study the chilling plant and its working cycle.
12. To determine sensible heat factor of Air on re-circulated air- conditioning set up.
13. To Study the Mechanical heat pump and find its C.O.P.
14. To study the Air and Water heat pump and find its C.O.P.

Course no: **MELB 38X**	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**Yes**	**No**
Type of Course	**Theory**		Elective	
Course Title	**Product Design & Development**			
Course Coordinator				
Course Objectives:	To familiarize the various concepts involved in the Design Process.			
Course Outcomes (COs)	CO-1	To understand the design principles.		
	CO-2	To analyze the consumers' needs.		
	CO-3	To design the concept of concurrent engineering		
	CO-4	To develop the various factors used in product design.		
	CO-5	To apply the concept of rapid prototyping & reverse engineering..		

Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	NIL				

Text Books:

1. Karl T. Ulrich and Steven D., "Product Design and Development", Eppinger, McGraw-Hill Education.
2. Andrearsen, M. M., and Hein, L., "Integrated Product Development", Springer.
3. Huang, G. Q., "Design for X: Concurrent Engineering Imperatives", Chapman and Hall.

Reference Books:	
	1. Chitale, A. K. and Gutpa, R. C., "Product Design and Manufacturing", Prentice Hall. 2. Boothroyd G., Dewhurst P., and Knight, "Product Design for Manufacture and Assembly", 2nd 2002 Ed., Marcel Dekker. 3. Chua, C. K and. Leong, K. F., "Rapid Prototyping: Principles and Applications in Manufacturing", John Wiley & Sons.
Content	**UNIT - I** **Introduction & Product Design:** Product Design and Development Process, Significance of Product Design, Sequential Engineering Design Method (Traditional and Modern), Challenges of Product Development; Evaluation of new Product Ideas – Functional, Technological, Ecological, and Legal etc. **UNIT- II** **Need for Developing Products:** Relevance of product lifecycle issues in design – designing to codes and standards - societal considerations in engineering design, establishing markets- market segments- relevance of market research. **UNIT III** **Concurrent Engineering:** Concept of concurrent engineering; Design for manufacturability (DFM); Design for assemblability (DFA); Design for reliability (DFR); Design for quality (DFQ). **UNIT IV** **Industrial Design –** human factors design –user friendly design – design for serviceability – design for environment – prototyping and testing – cost evaluation –categories of cost – overhead costs – activity based costing – methods of developing cost estimates – manufacturing cost –value analysis in costing **UNIT V** **Rapid Prototyping & Reverse Engineering:** Introduction, Various Types of Rapid Prototyping Processes, 3-D Printing. Concept of reverse engineering, Wireframe Modeling, Surface Modeling, Solid modeling.
Course Assessment	**Theory (100%):** Continuous Evaluation 25%, Mid Semester 25% End Semester 50%