Dr. Babasaheb Ambedkar Technological University (Established as University of Technology in the State of Maharashtra)
(Under Maharashtra Act No. XXIX of 2014)
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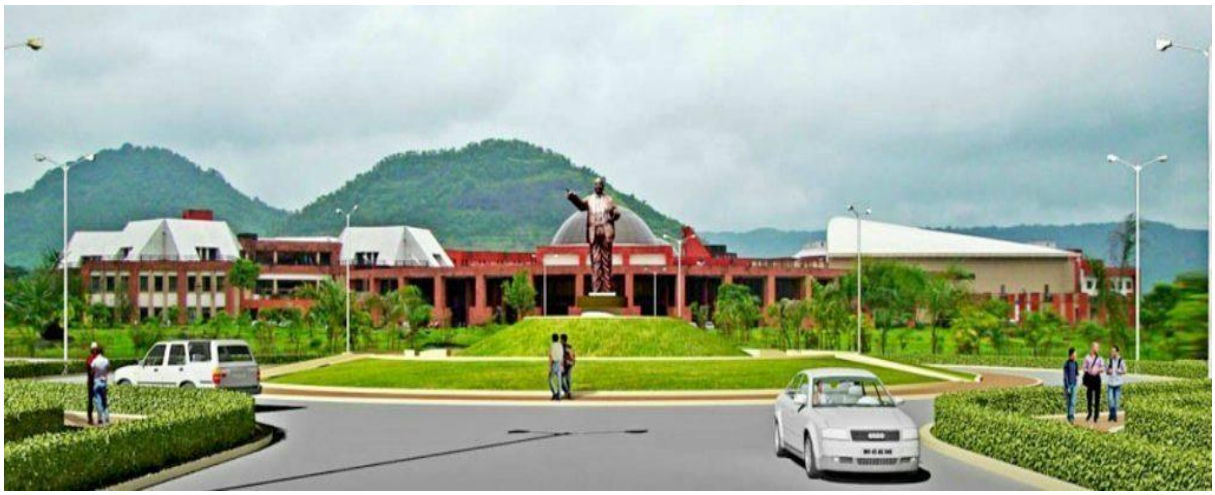
PROPOSED CURRICULUM
UNDER GRADUATE PROGRAMME
B. TECH

MECHANICAL AND AUTOMATION ENGINEERING

B. Tech Third & Final Year

2024-2025

(AFFILIATED INSTITUTES)



Vision

The vision of the department is to achieve excellence in teaching, learning, research and transfer of technology and overall development of students.

Mission

Imparting quality education, looking after holistic development of students and conducting need based research and extension.

Graduate Attributes

The Graduate Attributes are the knowledge skills and attitudes which the students have at the time of graduation. These Graduate Attributes identified by National Board of Accreditation are as follows:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
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.
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.
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.
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.
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.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
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.
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.
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 Educational Objectives

PEO1	Graduates should excel in engineering positions in industry and other organizations that emphasize design and implementation of engineering systems and devices.
PEO2	Graduates should excel in best post-graduate engineering institutes, reaching advanced degrees in engineering and related discipline.
PEO3	Within several years from graduation, alumni should have established a successful career in an engineering-related multidisciplinary field, leading or participating effectively in interdisciplinary engineering projects, as well as continuously adapting to changing technologies.
PEO4	Graduates are expected to continue personal development through professional study and self-learning.
PEO5	Graduates are expected to be good citizens and cultured human beings, with full appreciation of the importance of professional, ethical and societal responsibilities.

Program Outcomes

At the end of the program the student will be able to:

PO1	Apply knowledge of mathematics, science and engineering to analyze, design and evaluate mechanical components and systems using state-of-the-art IT tools.
PO2	Analyze problems of production engineering including manufacturing and industrial systems to formulate design requirements.
PO3	Design, implement and evaluate production systems and processes considering public health, safety, cultural, societal and environmental issues.
PO4	Design and conduct experiments using domain knowledge and analyze data to arrive at valid conclusions.
PO5	Apply current techniques, skills, knowledge and computer based methods and tools to develop production systems.
PO6	Analyze the local and global impact of modern technologies on individual organizations, society and culture.
PO7	Apply knowledge of contemporary issues to investigate and solve problems with a concern for sustainability and eco-friendly environment.
PO8	Exhibit responsibility in professional, ethical, legal, security and social issues.
PO9	Function effectively in teams, in diverse and multidisciplinary areas to accomplish common goals.
PO10	Communicate effectively in diverse groups and exhibit leadership qualities.
PO11	Apply management principles to manage projects in multidisciplinary environment.
PO12	Pursue life-long learning as a means to enhance knowledge and skills.

Rules and Regulations

1. The normal duration of the course leading to B.Tech. degree will be eight semesters.
2. The normal duration of the course leading to M.Tech. degree will be four semesters.
3. Each academic year shall be divided into 2 semesters, each of 20 weeks duration, including evaluation and grade finalization, etc. The Academic Session in each semester shall provide for at least 90 Teaching Days, with at least 40 hours of teaching contact periods in a five to six days session per week. The semester that is typically from Mid-July to November is called the ODD SEMESTER, and the one that is from January to Mid-May is called the EVEN SEMESTER. Academic Session may be scheduled for the Summer Session/Semester as well. For 1st year B. Tech and M. Tech the schedule will be decided as per the admission schedule declared by Government of Maharashtra.

4. The schedule of academic activities for a Semester, including the dates of registration, mid-semester examination, end-semester examination, inter-semester vacation, etc. shall be referred to as the Academic Calendar of the Semester, which shall be prepared by the Dean (Academic), and announced at least TWO weeks before the Closing Date of the previous Semester.
5. The Academic Calendar must be strictly adhered to, and all other activities including co-curricular and/or extra -curricular activities must be scheduled so as not to interfere with the Curricular Activities as stipulated in the Academic Calendar.

REGISTRATION:

1. Lower and Upper Limits for Course Credits Registered in a Semester, by a Full-Time Student of a UG/PG Programme:

A full-time student of a particular UG/PG Programme shall register for the appropriate number of course credits in each semester/session that is within the minimum and maximum limits specific to that UG/PG Programme as stipulated in the specific Regulations pertaining to that UG/PG Programme.

2. Mandatory Pre-Registration for higher semesters:
   In order to facilitate proper planning of the academic activities of a semester, it is essential for the every institute to inform to Dean (Academics) and COE regarding details of total no. of electives offered (Course-wise) along with the number of students opted for the same. This information should be submitted within two weeks from the date of commencement of the semester as per academic calendar.
3. PhD students can register for any of PG/PhD courses and the corresponding rules of evaluation will apply.
4. Under Graduate students may be permitted to register for a few selected Post Graduate courses, in exceptionally rare circumstances, only if the DUGC/DPGC is convinced of the level of the academic achievement and the potential in a student.

Course Pre-Requisites:

1. In order to register for some courses, it may be required either to have exposure in, or to have completed satisfactorily, or to have prior earned credits in, some specified courses.
2. Students who do not register on the day announced for the purpose may be permitted LATE REGISTRATION up to the notified day in academic calendar on payment of late fee.
3. REGISTRATION IN ABSENTIA will be allowed only in exceptional cases with the approval of the Dean (Academic) / Principal.

4. A student will be permitted to register in the next semester only if he fulfills the following conditions:

   (a) Satisfied all the Academic Requirements to continue with the Programme of Studies without termination
   (b) Cleared all Institute, Hostel and Library dues and fines (if any) of the previous semesters;
   (c) Paid all required advance payments of the Institute and hostel for the current semester;
   (d) Not been debarred from registering on any specific ground by the Institute.

EVALUATION SYSTEM:

1. Absolute grading system based on absolute marks as indicated below will be implementeds from academic year 2019-20,starting from I year B.Tech.

Perentage of marks	Letter grade	Grade point
91-100	EX	10.0
86-90	AA	9.0
81-85	AB	8.5
76-80	BB	8.0
71-75	BC	7.5
66-70	CC	7.0
61-65	CD	6.5
56-60	DD	6.0
51-55	DE	5.5
40-50	EE	5.0
<40	EF	0.0

2. Class is awdared based on CGPA of all eigth semster of B.Tech Program.

CGPA for pass is minimum 5.0	
CGPAupto<5.50	Pass class
CGPA ≥ 5.50 &<6.00	SecondClass
CGPA ≥ 6.00 &<7.50	First Class
CGPA ≥ 7.50	Distinction
[Percentage of Marks =CGPA*10.0]	

A total of 100 Marks for each theory course are distributed as follows:

	MidSemester Exam (MSE) Marks	20
	ContinuousAssesment Marks	20

	End SemesterExamination(ESE)Marks	60

4.A total of 100 Marks for each practical course are distributed as follows:

1.	Continuous Assesment Marks	60
2.	End Semester Examination (ESE)Marks	40

It is mandatory for every student of B.Tech. to score a minimum of 40 marks out of 100, with a minimum of 20 marks out of 60 marks in End Semester Examination for theory course.

This will be implemented from the first year of B.Tech starting from Academic Year 2019-20

5. Description of Grades:

EX Grade: An 'EX' grade stands for outstanding achievement.
EE Grade: The 'EE' grade stands for minimum passing grade.
The students may appear for the remedial examination for the subjects he/she failed for the current semester of admission only and his/her performance will be awarded with EE grade only.
If any of the student remain Absent for the regular examination due to genuine reason and the same will be verified and tested by the Dean (Academics) or committee constituted by the University Authority.

FF Grade: The 'FF' grade denotes very poor performance, i.e. failure in a course due to poor performance. The students who have been awarded 'FF' grade in a course in any semester must repeat the subject in next semester.

6. Evaluation of Performance:

1. Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA)

(A) Semester Grade Point Average (SGPA) The performance of a student in a semester is indicated by Semester Grade Point Average (SGPA) which is a weighted average of the grade points obtained in all the courses taken by the student in the semester and scaled to a maximum of 10. (SGPI is to be calculated up to two decimal places). A Semester Grade Point Average (SGPA) will be computed for each semester as follows:

$$SGPA = \frac{[\sum_{i=1}^{n} c_i\, g_i]}{[\sum_{i=1}^{n} c_i\,]}$$

Where
'n' is the number of subjects for the semester,
'c_i' is the number of credits allotted to a particular subject, and
'g_i' is the grade-points awarded to the student for the subject based on his performance as
per the above table.
-SGPA will be rounded off to the second place of decimal and recorded as such.

(B) Cumulative Grade Point Average (CGPA): An up-to date assessment of the overall performance of a student from the time he entered the Institute is obtained by calculating Cumulative Grade Point Average (CGPA) of a student. The CGPA is weighted average of the grade points obtained in all the courses registered by the student since s/he entered the Institute. CGPA is also calculated at the end of every semester (up to two decimal places). Starting from the first semester at the end of each semester (S), a Cumulative Grade Point Average (CGPA) will be computed as follows:

$$CGPA = \frac{[\sum_{i=1}^{m} c_i\, g_i]}{[\sum_{i=1}^{m} c_i\,]}$$

Where
'm' is the total number of subjects from the first semester onwards up to and including the semester S,
'ci' is the number of credits allotted to a particular subject, and
'gi' is the grade-points awarded to the student for the subject based on his/her performance as per the above table.

-CGPA will be rounded off to the second place of decimal and recorded as such.

Award of Degree of Honours
Major Degree
The concept of Major and Minors at B.Tech level is introduced , to enhance learning skills of students, acquisition of additional knowledge in domains other than the discipline being pursued by the student, to make the students better employable with additional knowledge and encourage students to pursue cross-discipline research.

A. <u>Eligibility Criteria for Majors</u>

1. The Student should have Minimum CGPA of 7.5 up to 4th Semester
2. Student willing to opt for majors has to register at the beginning of 5th Semester

3. The Student has to complete 5 additional advanced courses from the same discipline specified in the curriculum. These five courses should be of 4 credits each amounting to 20 credits. The students should complete these credits before the end of last semester.
4. Student may opt for the courses from NPTEL/ SWAYAM platform. (if the credits of NPTEL/ SWAYAM courses do not match with the existing subject proper scaling will be done)

Student complying with these criteria will be awarded B.Tech (Honours) Degree.

B. <u>Eligibility Criteria for Minors</u>

1. The Student should have Minimum CGPA of 7.5 up to 4th Semester
2. Student willing to opt for minors has to register at the beginning of 5th Semester
3. The Student has to complete 5 additional courses from other discipline of their interest, which are specified in the respective discipline. These five courses should be of 4 credits each amounting to 20 credits.
4. Student may opt for the courses from NPTEL/ SWAYAM platform. (if the credits of NPTEL/ SWAYAM courses do not match with the existing subject proper scaling will be done)

Student complying with these criteria will be awarded with B.Tech Degree in -------Engineering with Minor in ------ --Engineering.
(For e.g.: B. Tech in Civil Engineering with Minor in Computer Engineering)

For applying for Honours and Minor Degree the student has to register themselves through the proper system.

ATTENDANCE REQUIREMENTS:

1. All students must attend every lecture, tutorial and practical classes.
2. To account for approved leave of absence (eg. representing the Institute in sports, games or athletics; placement activities; NCC/NSS activities; etc.) and/or any other such contingencies like medical emergencies, etc., the attendance requirement shall be a minimum of 75% of the classes actually conducted.

If the student failed to maintain 75% attendance, he/she will be detained for appearing the successive examination.

The Dean (Academics)/ Principal is permitted to give 10% concession for the genuine reasons as such the case may be.

In any case the student will not be permitted for appearing the examination if the attendance is less than 65%.

3. The course instructor handling a course must finalize the attendance 3 calendar days before the last day of classes in the current semester and communicate clearly to the students by displaying prominently in the department and also in report writing to the head of the department concerned.
4. The attendance records are to be maintained by the course instructor and he shall show it to the student, if and when required.

TRANSFER OF CREDITS

The courses credited elsewhere, in Indian or foreign University/Institutions/ Colleges/Swayam Courses by students during their study period at DBATU may count towards the credit requirements for the award of degree. The guidelines for such transfer of credits are as follows:

a) 20 % of the total credit will be considered for respective calculations.

b) Credits transferred will be considered for overall credits requirements of the programme.

c) Credits transfer can be considered only for the course at same level i.e UG, PG etc.

d) A student must provide all details (original or attested authentic copies)such as course contents, number of contact hours, course instructor /project guide and evaluation system for the course for which he is requesting a credits transfer. He shall also provide the approval or acceptance letter from the other side. These details will be evaluated by the concerned Board of Studies before giving approval. The Board of Studies will then decide the number of equivalent credits the student will get for such course(s) in DBATU. The complete details will then be forwarded to Dean for approval.

e) A student has to get minimum passing grades/ marks for such courses for which the credits transfers are to be made.

f) Credits transfers availed by a student shall be properly recorded on academic record(s) of the student.

g) In exceptional cases, the students may opt for higher credits than the prescribed.

Abbreviations

BSC: *Basic Science Course*

ESC: *Engineering Science Course*

PCC: *Professional Core Course*

PEC: *Professional Elective Course*

OEC: *Open Elective Course*

HSSMC: *Humanities and Social Science including Management Courses*

PROJ: *Project work, seminar and internship in industry or elsewhere*

Basic Science Course (BSC)		
BTBS101	Engineering Mathematics- I	(3-1-0)4
BTBS102	Engineering Physics	(3-1-0)4
BTBS107L	Engineering Physics Lab	(0-0-2)1
BTBS201	Engineering Mathematics-II	(3-1-0)4
BTBS202	Engineering Chemistry	(3-1-0)4
BTBS207L	Engineering Chemistry Lab	(0-0-2)1
BTBS301	Engineering Mathematics – III	(3-1-0)4
Engineering Science Course (ESC)		
BTES103	Engineering Graphics	(2-0-0)2
BTES105	Energy and Environment Engineering	(2-0-0)2
BTES106	Basic Civil & Mechanical Engineering	(2-0-0)Audit
BTES108L	Engineering Graphics Lab	(0-0-4)2
BTES203	Engineering Mechanics	(2-1-0)3
BTES204	Computer Programming	(3-0-0)3
BTES205	Basic Electrical and Electronics Engineering	(2-0-0)Audit
BTES206L	Workshop Practice	(0-0-4)2
BTES208L	Engineering Mechanics Lab	(0-0-2)1
BTMES304	Materials Science and Metallurgy	(3-1-0)4
BTMES404	Strength of Materials	(3-1-0)4
Online course	Artificial Intelligence*	(3-0-0)3
Humanities and Social Science Including Management Courses (HSSMC)		
BTHM104	Communication Skills	(2-0-0)2
BTHM109L	Communication Skills Lab	(0-0-2)1
BTHM403	Basic Human Rights	(3-0-0)3
BTHM702	Industrial Engineering and Management	(3-1-0)4
	Constitution of India*	(1-0-0)1
Professional Core Course (PCC)		
BTMC302	Fluid Mechanics	(3-1-0)4
BTMC303	Thermodynamics	(3-1-0)4
BTMCL305	Machine Drawing and CAD Lab	(0-0-4)2
BTMCL306	Mechanical Engineering Lab - I	(0-0-4) 2
BTMC401	Manufacturing Processes – I	(3-1-0)4
BTMC402	Theory of Machines-I	(3-1-0)4
BTMCL406	Mechanical Engineering Lab-II	(0-0-4) 2
BTMC 501	Heat Transfer	(3-1-0)4
BTMC 502	Machine Design – I	(3-1-0)4
BTMC 503	Theory of Machines- II	(3-1-0)4
BTMC506	Applied Thermodynamics	(3-1-0)4
BTMCL 507	Mechanical Engineering Lab - III	(0-0-6) 3
BTMC 601	Manufacturing Processes- II	(3-1-0)4
BTMC 602	Machine Design-II	(3-1-0)4
BTMCL 606	Mechanical Engineering Lab – IV	(0-0-6) 3
BTMC701	Mechatronics	(3-1-0)4
BTMCL706	Mechanical Engineering Lab –V	(0-0-6) 3
Professional Elective Course (PEC)		
BTMPE405A	Numerical Methods in Engineering	(3-1-0) 4
BTMPE405B	Sheet Metal Engineering	(3-1-0) 4
BTMPE405C	Fluid Machinery	(3-1-0) 4
BTMPE504A	Refrigeration and Air conditioning	(3-0-0)3
BTMPE504B	Steam and Gas Turbines	(3-0-0)3
BTMPE504C	Engineering Tribology	(3-0-0)3
BTAPE504A	Automobile Design	(3-0-0)3
BTAPE504D	Automobile Engineering	(3-0-0)3
BTMPE603A	IC Engines	(3-0-0)3
BTMPE603B	Mechanical Vibrations	(3-0-0)3

BTMPE603C	Machine Tool Design	(3-0-0)3
BTMPE603D	Engineering Metrology and Quality Control	(3-0-0)3
BTAPE603D	Automobile Body Design (Pre-requisite: Automobile Design)	(3-0-0)3
BTAPE603E	E – Vehicles	(3-0-0)3
BTMPE604A	Process Equipment Design	(3-0-0)3
BTMPE604B	Product Life Cycle Management	(3-0-0)3
BTMPE604C	Finite Element Method	(3-0-0)3
BTMPE604D	Robotics	(3-0-0)3
BTAPE604B	Computational Fluid Dynamics	(3-0-0)3
BTMPE703A	Design of Air Conditioning Systems	(3-0-0)3
BTMPE703B	Biomechanics	(3-0-0)3
BTMPE703C	Non-conventional Machining	(3-0-0)3
BTMPE703D	Advanced IC Engines	(3-0-0)3
BTMPE703E	Additive Manufacturing	(3-0-0)3
BTMPE703F	Surface Engineering	(3-0-0)3
BTPPE703D	Processing of Polymers	(3-0-0)3
Open Elective Course (OEC)		
BTMOE505A	Solar Energy	(3-0-0)3
BTMOE505B	Renewable Energy Sources	(3-0-0)3
BTMOE505C	Human Resource Management	(3-0-0)3
BTMOE505D	Product Design Engineering	(3-0-0)3
BTMOE605A	Quantitative Techniques and Project Management	(3-1-0) 3
BTMOE605B	Nanotechnology	(3-1-0) 4
BTMOE605C	Energy Conservation and Management	(3-1-0) 4
BTMOE605D	Wind Energy	(3-0-0) 3
BTMOE605E	Introduction to Probability Theory and Statistics	(3-1-0) 4
BTMOE704A	Sustainable Development	(3-0-0)3
BTMOE704B	Entrepreneurship Development	(3-0-0)3
BTMOE704C	Plant Maintenance	(3-0-0)3
BTMOE705A	Engineering Economics	(3-0-0)3
BTMOE705B	Biology for Engineers	(3-0-0)3
BTMOE705C	Intellectual Property Rights	(3-0-0)3
Seminar/Mini Project/ Internship		
BTES209P	IT – 1 Evaluation	(0-0-0)1
BTMI 407	IT – 2 Evaluation	(0-0-0) 1
BTMS607	B Tech Seminar	(0-0-2)1
BTMP 608	Mini Project (TPCS)	(0-0-2)2
BTMI609	IT – 3 Evaluation	(0-0-0)1
Project (MP)		
BTAP801/ BTAI801	Project work/ Internship	(0-0-24)12

Suggested Plan of Study

Number of Courses	Semester							
	I	II	III	IV	V	VI	VII	VIII
1	BTBS101 Engineering Mathematics - I	BTBS201 Engineering Mathematics- II	BTBS301 Engineering Mathematics – III	BTMAC304 Manufacturing Processes – I	BTMC 501 Heat Transfer	BTMC 601 Manufacturing Processes- II	BTMC701 Mechatronics	BTMP801/ BTMI801 Project Work
2	BTBS102 Engineering Physics	BTBS202 Engineering Chemistry	BTMC302 Fluid Mechanics	BTMC402 Theory of Machines-I	BTMC 502 Machine Design – I	BTMC 602 Machine Design-II	BTHM702 Industrial Engineering and Management	--
3	BTES103 Engineering Graphics	BTES203 Engineering Mechanics	BTMC303 Thermodynamics	BTHM403 Basic Human Rights	BTMC 503 Theory of Machines- II	BTMPE 603A-D BTAPE 603C,E (Elective III)	BTMPE703A-F BTPPE703D (Elective V)	--
4	BTHM104 Communication Skills	BTES204 Computer Programming	BTMES304 Materials Science and Metallurgy	BTMES404 Strength of Materials	BTMPE 504A-C BTAPE504A,D Elective-II	BTMPE 604A-D BTAPE 604B (Elective IV)	BTMOE704 (Open Elective III)	--
5	BTES105 Energy and Environment Engineering	BTES205 Basic Electrical and Electronics Engineering	BTMCL305 Machine Drawing and CAD Lab	BTMPE405A-D (Elective-I)	BTMOE 505A-D (Open Elective I)	BTMOE605 (Open Elective II)	BTMOE705 (Open Elective IV)	--
6	BTES106 Basic Civil and Mechanical Engineering	BTES206L Workshop Practice	BTMCL306 Mechanical Engineering Lab – I	BTMCL406 Mechanical Engineering Lab-II	BTMC 506 Applied Thermodynamics	BTMCL 606 Mechanical Engineering Lab - IV	BTMCL706 Mechanical Engineering Lab –V	--
7	BTBS107L Engineering Physics Lab	BTBS207L Engineering Chemistry Lab	BTES209P (IT – 1 Evaluation)	BTMI407 (IT – 2)	BTMCL 507 Mechanical Engineering Lab - III	BTMS607 B Tech Seminar	BTMI609 (IT – 3 Evaluation)	--
8	BTES108L Engineering Graphics Lab	BTES208L Engineering Mechanics Lab	BTHM307 Constitution of India	--	BTMI 407 (IT – 2 Evaluation)	BTMP608 Mini Project (TPCS)	----	--
9	BTHM109L Communication Skills Lab	BTES209P (IT - 1)	--	--	Artificial Intelligence	BTMI 609 (IT – 3)	-	--
10	--	--	--	--	--	--	--	--

Degree Requirements: **Total Credits: 160**

Sr. No.	Category	Number of Subjects in Each Category	Suggested Breakup of Credits by AICTE (Total 160)	Total
1	Humanities and Social Sciences including Management courses	4	12	**10**
2	Basic Science courses	7+1*	25	**22+3***
3	Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc.	11	24	**23**
4	Professional core courses	17	48	**59**
5	Professional Elective courses relevant to chosen specialization/branch	5	18	**16**
6	Open subjects – Electives from other technical and /or emerging subjects	4	18	**12**
7	Project work, seminar and internship in industry or elsewhere	6	15	**18**
8	Mandatory Courses [Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Knowledge Tradition]	2+1*	NC	--
	Total	**56+2**	**160***	**163**

*Over and above of 160 credits

Sr.No	Category	Suggested Breakup of Credits (Total 160)	First year		Second year		Third year		Final year		Total
			I	II	III	IV	V	VI	VII	VIII	
1	Humanities and Social Sciences including Management courses	12	03	--	--	03		--	04	--	**10**
2	Basic Science courses	25	09	09	04	3*	--	--	--	--	**22+3***
3	Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc.	24	06	09	04	04	--	--	--	--	**23**
4	Professional core courses	48	--	--	12	10	19	11	07	--	**59**
5	Professional Elective courses relevant to chosen specialization/branch	18	--	--	--	04	03	06	03	--	**16**
6	Open subjects – Electives from other technical and /or emerging subjects	18	--	--	--	--	03	03	06	--	**12**
7	Project work, seminar and internship in industry or elsewhere	15	--	--	01	--	01	03	01	12	**18**
8	Mandatory Courses [Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Knowledge Tradition]	NC	--	--	--	--	--	--	--	--	--
	Semester wise credits		18	18	21	24	26	23	21	12	**163**
	Total	**160**	**36**		**45**		**49**		**33**		

*Over and above of 160 credits

Course Structure for Semester V
B. Tech in Mechanical and Automation Engineering (w. e. f. 2024-25)

Semester V										
Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				No. of Credits
			L	T	P	CA	MSE	ESE	Total	
PCC 09	BTMC 501	Heat Transfer	3	1	-	20	20	60	100	4
PCC 10	BTMC 502	Machine Design – I	3	1	-	20	20	60	100	4
PCC 11	BTMAC 503	CAD, CAM and CIM	3	1	-	20	20	60	100	4
PEC 2	BTMPE 504A/B BTAPE504D	Elective-II	3	-	-	20	20	60	100	3
OEC 1	BTMOE 505A/B/C	Open Elective-I	3	-	-	20	20	60	100	3
PCC12	BTMACL 506	CAD CAM Lab	-	-	2	60	-	40	100	1
PCC13	BTMACL 507	Machine Design – I Lab	-	-	2	60	-	40	100	1
PCC14	BTMACL 508	Heat Transfer Lab	-	-	2	60	-	40	100	1
PROJ-2	BTMI 408	IT – 2 Evaluation	-	-	-	-	-	100	100	1
Total			**15**	**3**	**6**	**280**	**100**	**520**	**900**	**22**

Elective- II

Sr. No	Course code	Course Name
1	BTMPE504A	Refrigeration and Air conditioning
2	BTMPE504B	Steam and Gas Turbines
3	BTAPE504D	Automobile Engineering

Open Elective- I

Sr. No.	Course code	Course Name
1	BTMOE505A	Solar Energy
2	BTMOE505B	Renewable Energy Sources
3	BTMOE505C	Human Resource Management

Course Structure for Semester VI
B. Tech in Mechanical and Automation Engineering (w. e. f. 2024-25)

Semester VI										
Course Category	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**				**No. of Credits**
			L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
PCC15	BTMAC601	Applied Hydraulics, Pneumatics and their controls	3	1	-	20	20	60	100	4
PCC16	BTMC 602	Machine Design-II	3	1	-	20	20	60	100	4
PEC3	BTMPE603C/D BTAPE603E	Elective-III	3	-	-	20	20	60	100	3
PEC4	BTMPE604A/B/C	Elective-IV	3	-	-	20	20	60	100	3
OEC2	BTMOE605A, BTMOE605C and BTMOE605D	Open Elective-II	3	1	-	20	20	60	100	3
PCC17	BTMACL606	Applied Hydraulics, Pneumatics Lab	-	-	2	60	-	40	100	1
PCC18	BTMACL607	Machine Design-II Lab	-	-	2	60	-	40	100	1
PEC5	BTMACL608	ELE-III Lab			2	60	-	40	100	1
PROJ-4	BTMAS610	B Tech Seminar	-	-	2	60		40	100	1
PROJ-5	BTMAP611	Mini Project (Development of small Automation system/ Simulation Model)	-	-	2	60	-	40	100	1
PROJ-6	BTMAI609 (IT-3)	Field Training / Industrial Training (minimum of 4 weeks which can be completed partially in fifth semester and sixth semester or in one semester itself).	-	-	-	-	-	-	-	Credits to be evaluated in Sem VII
		Total	**15**	**3**	**10**	**400**	**100**	**500**	**1000**	**22**

Elective-III

Sr. No	Course code	Course Name
1	BTMPE603C	Machine Tool Design
2	BTMPE603D	Engineering Metrology and Quality Control
3	BTAPE603E	E-Vehicles

Elective-IV

Sr. No	Course code	Course Name
1	BTMPE604A	Process Equipment Design
2	BTMPE604B	Product Life Cycle Management
3	BTMPE604C	Finite Element Method

Open Elective-II

Sr.No	Course code	Course Name
1	BTMOE605A	Quantitative Techniques and Project Management
2	BTMOE605C	Energy Conservation and Management
3	BTMOE605D	Wind Energy

Course Structure for Semester VII
B. Tech in Mechanical and Automation Engineering (w. e. f. 2025-26)

Semester VII										
Course Category	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**				**No. of Credits**
			L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
PCC18	BTMAC701	Robotics and Industrial Automation	3	1	-	20	20	60	100	4
HSSMC4	BTHM702	Industrial Engineering and Management	3		-	20	20	60	100	3
PEC6	BTMAPE703A/B/C	Elective-V	3	-	-	20	20	60	100	3
OEC3	BTMOE704A/B/C	Open Elective-III	3	-	-	20	20	60	100	3
OEC4	BTMOE705A/B/C	Open Elective-IV	3	-	-	20	20	60	100	3
PCC19	BTMACL706	Robotics and Industrial Automation Lab	-	-	2	60	-	40	100	1
PROJ-6	BTMP707	Mini Project 2			6	60		40	100	3
PROJ-7	BTMI609	IT – 3 Evaluation	-	-	-	-	-	100	100	1
Total			**15**	**1**	**08**	**220**	**100**	**480**	**800**	**21**

Elective-V

Sr. No	Course code	Course Name
1	BTMAPE703A	Additive manufacturing
2	BTMAPE703B	Process Control and Automation
3	BTMAPE703C	IOT in Automation.

Open Elective-III

Sr. No	Course code	Course Name
1	BTMOE704A	Sustainable Development (Refer Mechanical)
2	BTMOE704B	Entrepreneurship Development (Refer Mechanical)
3	BTMOE704C	Plant Maintenance (Refer Mechanical)

Open Elective-IV

Sr. No	Course code	Course Name
1	BTMOE705A	Engineering Economics (Refer Mechanical)
2	BTMOE705B	Biology for Engineers (Refer Mechanical)
3	BTMOE705C	Intellectual Property Rights (Refer Mechanical)

Course Structure for Semester VIII
B. Tech in Mechanical and Automation Engineering (w. e. f. 2025-26)

Semester VIII										
Course Category	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**				**Credit**
			L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
Choose any two subjects from ANNEXURE			-	-	-	20	20	60	100	4
			-	-	-	20	20	60	100	4
PROJ-8	BTMAP801/ BTMAI801	Project Work: Industry based and Internship / Institute level project	-	-	20	60	-	40	100	10
Total			**-**	**-**	**20**	**100**	**40**	**160**	**300**	**18**

SEM	I	II	III	IV	V	VI	VII	VIII	TOTAL
CREDITS	18	19	21	20	22	22	21	18	161

Annexure

Sr. NO	Course Code	Course Name	Duration in weeks	Institute Offering Course	Name of Professor
1	BTMAEC801A	Fundamentals of Automotive Systems	12 Weeks	IITM	Prof. C. S. Shankar Ram
2	BTMAEC801B	Introduction to Machine Learning	12 Weeks	IITM	Prof. Balaraman Ravindran
3	BTMAEC801C	Machinery Fault Diagnosis and Signal Processing	12 Weeks	IITKGP	Prof. Amiya Ranjan Mohanty
4	BTMAEC801D	Product Design and Manufacturing	12 Weeks	IITK	Prof. J.Ramkumar Prof. Amandeep Singh
5	BTMAEC801E	Advanced Robotics	12 Weeks	IITK	Prof. Ashish Dutta

Semester - V

Heat Transfer

BTMC 501	PCC 09	Heat Transfer	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Explain the laws of heat transfer and deduce the general heat conduction equation and to explain it for 1-D steady state heat transfer in regular shape bodies
CO2	Describe the critical radius of insulation, overall heat transfer coefficient, thermal conductivity and lumped heat transfer
CO3	Interpret the extended surfaces
CO4	Illustrate the boundary layer concept, dimensional analysis, forced and free convection under different conditions
CO5	Describe the Boiling heat transfer, Evaluate the heat exchanger and examine the LMTD and NTU methods applied to engineering problems
CO6	Explain the thermal radiation black body, emissivity and reflectivity and evaluation of view factor and radiation shields

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1			1				1			
CO2	3	2			1							
CO3	3	1			2		2		1			
CO4	3	3		1	1				1			
CO5	3	3	3		1		2					
CO6	2	3		2	2		2		1			

Course Contents

Unit 1: Introduction [08 Hours]

Heat transfer mechanism, conduction heat transfer, Thermal conductivity, Convection heat transfer, Radiation heat transfer, laws of heat transfer, Steady State Conduction: General heat conduction equation, Boundary and initial Conditions, one dimensional steady state conduction: the slab, the cylinder, the sphere, composite systems.

Unit 2: Overall Heat Transfer and Extended Surfaces [08 Hours]

Thermal contact resistance, Critical radius of insulation, Electrical analogy and Overall heat transfer coefficient, Heat source systems, Variable thermal conductivity, extended surfaces. Unsteady State Conduction: Lumped system analysis, Biot and Fourier number, Heisler chart **(Numerical examples).**

Unit 3: Principles of Convection [08 Hours]

Continuity, Momentum and Energy equations, Hydrodynamic and Thermal boundary layer for a flat plate and pipe flow. Dimensionless groups force convection, relation between fluid friction and heat transfer, turbulent boundary layer heat transfer. Forced Convection: Empirical relations for pipe and tube flow, flow across cylinders, spheres, tube banks. Free Convection**:** Free convection from a vertical, inclined and horizontal surface, cylinder and sphere. (Numerical examples).

Unit 4: Heat Exchangers [08 Hours]

Heat Exchangers: Classification of heat exchangers, temperature distribution in parallel counter flow arrangement, the overall heat transfer coefficient, Analysis of heat exchangers, the log mean temperature difference (LMTD) method, the effectiveness- NTU method, selection of heat exchangers, Introduction to TEMA standard. (Numerical examples).

Unit 5: Radiation Heat Transfer [08 Hours]

Introduction, thermal radiation, Black body radiation, radiation laws, Radiation properties, Atmospheric and Solar radiation, The view factor, Radiation heat transfer from black surfaces, gray surfaces, diffuse surfaces, Radiation shields and the radiation effect.
(Numerical examples)

Texts books

1. F. P. Incoropera, D. P. Dewitt, "FundamentalsofHeatandMassTransfer",John-Wiley,5th edition, 1990.
2. S. P. Sukhatme, "A Text book on Heat Transfer", Tata McGraw Hill Publications, 3rd edition.

References:

1. Y.A. Cengel, "Heat Transfer–A Practical Approach", Tata McGraw Hill Publications, 3rdedition,2006.
2. J. P. Holman, "Heat Transfer", Tata McGraw Hill Publications,9th edition,2004.

Machine Design - I

BTMC 502	PCC 10	Machine Design - I	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs./week Tutorial: 1 hrs./week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: Strength of Materials

Course Outcomes: At the end of the course, students will be able to:

CO1	Formulate the problem by identifying customer need and convert into design specification
CO2	Understand component behavior subjected to loads and identify failure criteria
CO3	Analyze the stresses and strain induced in the component
CO4	Design of machine component using theories of failures
CO5	Design of component for finite life and infinite life when subjected to fluctuating load
CO6	Design of components like shaft, key, coupling, screw and spring

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1						1				1
CO2	3	2		1		1		1		1		1
CO3	1	1				1		1		1		1
CO4	3	3	2	1		2		1		1		1
CO5	1	1				1		1		1		1
CO6	2	2	2	1		1		1		1		1

Course Contents

Unit 1: Mechanical Engineering Design Process [08 Hours]

Traditional design methods, general industrial design procedure, design considerations, phases in design, creativity in design, use of standardization, preferred series, introduction to ISO9000, use of design data book, aesthetic and ergonomic considerations in design.

Unit 2: Design of Machine Elements against Static Loading [08 Hours]

Theories of Failure (Yield and Fracture Criteria): Maximum normal stress theory, Maximum shear stress theory, Maximum distortion energy theory, comparison of various theories of failure, Direct loading and combined loading, Joints subjected to static loading e.g. cotter and knuckle joint.

Unit 3: Design against Fluctuating Loads [08 Hours]

Stress concentration, stress concentration factors, fluctuating stresses, fatigue failure, endurance limit, notch sensitivity, approximate estimation of endurance limit, design for finite life and finite life under reversed stresses, cumulative damage in fatigue, Soderberg and Goodman diagrams, fatigue design under combined stresses.

Unit 4: Design of Shafts Keys and Couplings [08 Hours]

Various design considerations in transmission shafts, splined shafts, spindle and axle strength, lateral and torsional rigidity, ASME code for designing transmission shaft.

Types of Keys**:** Classification and fitment in key ways, Design of various types of keys. Couplings**:** Design consideration, design of rigid, muff and flange type couplings and design of flexible couplings.

Unit 5: Design of Threaded Joints and Spring [08 Hours]

Power Screws**:** Forms of threads used for power screw and their applications, torque analysis for square threads, efficiency of screw, overall efficiency, self- locking in power screws, stresses in the power screw, design of screw and nut, differential and compound screw, Re-circulating ball screw.

Welded Joints**:** Type of welded joints, stresses in butt and fillet welds, strength of welded joints subjected to bending moments.

Mechanical Springs: Stress deflection equation for helical spring, Wahl's factor, style of ends, design of helical compression, shot peening.

Texts:

1. V. B. Bhandari, "Design of Machine Elements", Tata McGraw Hill Publications, New Delhi, 2008.
2. R. L. Nortan, "Machine Design: An Integrated Approach", Pearson Education Singapore, 2001.

References:

1. R.C. Juvinall, K. M. Marshek, " Fundamental of machine component design", John Wiley & Sons Inc., New York, 3rd edition,2002.
2. B. J. Hamrock, B. Jacob son and Schmid Sr.," Fundamentals of Machine Elements", International Edition, NewYork, 2nd edition, 1999.
3. A. S. Hall, A. R. Holowenko, H. G. Langhlin, "Theory and Problems of Machine Design", Schaum's Outline Series, Tata McGraw Hill book Company, New York, 1982.
4. J. E. Shigley and C. Mischke, "Mechanical Engineering Design", Tata McGraw Hill Publications, 7th edition, 2004.
5. M. F. Spotts, "Design of Machine Elements", Prentice Hall of India, New Delhi.

CAD, CAM and CIM

BTMAC 503	PCC 11	CAD, CAM and CIM	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Course Outcomes: At the end of the course, students will be able to:

CO1	Understand Concept, need and benefits of CAD, CAM, CAE and CIM
CO2	Understand the necessary theoretical background and demonstrates the application of computer graphics in 2D and 3D modeling
CO3	Understand the concept Methods , and Application of 3D Modeling and utilize 3D surface and 3D solid modeling tools to create and edit more complex designs. T
CO4	Understand role of computer and automation & computer based integration in manufacturing
CO5	Evaluate manufacturing assignment based on critical thinking and problem solving skills, the automated control of machining tools using a computer

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO1	PO12
CO1	3		3	3			1	1	1	1	1	1
CO2	3		2	1	2							
CO3	3	3	2			2						
CO4	3	2	3	2	2	2	1	1	1	1	1	1
CO5	2	1	2	3	2	3	2	1	3	1	1	

Course Contents

Unit 1: Introduction – CAD, CAM, CAE **[08 Hours]**

Concepts of CAD, CAM, CAE, Product Life cycle Management – Concept, need and benefits, Product design process, and CAD, Principles of concurrent engineering, manufacturing data base, Benefits of CAD.

Unit 2: Graphics Software **[08 Hours]**

Ground rules for graphics software. Software and hardware configuration of graphics system, Functions of graphics system, 2D and 3D transformations of geometric models like translation,scaling, rotation, reflection, shear; homogeneous representations, concatenated representation; Orthographic projections.

Unit 3: 3D Modelling **[08 Hours]**

Wire frame modelling, solid modelling, Modern solid modeling techniques, their need and advantages, feature based modeling, parametric modeling, constraint-based modeling and hybrid solid modelers, Solid Representation: boundary representation, constructive solid geometry, sweep representations, primitive instancing, cell decomposition, Parametric and non-parametric representation of Beizer curve, B-Spline curve, Kinds of Surfaces, Assembly modeling: Representation, mating conditions, representation schemes, generation of assembling sequences. An overview of modeling softwares like UG/NX, Solid Works,
Autodesk Inventor, AutoCAD, PRO/E, CATIA.

Unit 4: CIM, CAPP, FMS **[08 Hours]**

Definition, Computer Integrated Manufacturing (CIM), Advantages and Limitations of Automation, Flexible Manufacturing System (FMS), Elements of FMS, Applications of FMS, Merits and Demerits in FMS, Group Technology, Merits and Demerits of Group Technology, Part classification and coding system, CAPP

Unit 5: NC Machine Tools **[08 Hours]**

Basic components of NC, CNC and DNC system, Coordinate System, NC motion control systems, drive of NC systems, NC Part programming: Manual, APT, Post Processor,
CNC controllers, Features and Advantages of CNC.

Text-books/References:

1. CAD/CAM by M.P. Grover. And E.W. Zimmer, Prentice Hall of India Pvt .Ltd.
2. CAD/CAM–Principle Practice and Manufacturing Management, ChrisMcMahonand Jimmie Browne Addision Wesley England.
3. CAD/CAM Theory and Practice, Ibrahim Zeid, TMH.
4. CAD/CAM Principles and Application ,Rao P.N.,-TMH.
5. Automation, Production Systems and Computer Integrated Manufacturing, Grover M.P.- Prentice Hall of India.
6. Mathematical Elements for Computer Graphics, Rogers, D.F. and Adams, A., McGraw Hill Inc.
7. CAD/CAM/CIM, P.Radhakrishnan, S.Subramanayan and V.Raju, NewAge International
8. Computer Aided Manufacturing, P.N. Rao, NK Tewari and TK Kundra
9. Numerical Control Machines-P.S .Pabla, PHI Pub.
10. Numerical Control machine tools– Yoran Koran/Joseph Ben, Khanna Publication.

Elective-II

Refrigeration and Air-Conditioning

BTMPE504A	PEC 2	Refrigeration and Air Conditioning	3-0-0	3 Credits

Teaching Scheme:	Examination Scheme:
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Course Outcomes: At the end of the course, students will be able to:

CO1	Understand the concept of refrigeration and its unit. Explain air refrigeration cycle and its application in aircraft, properties of refrigerants and their selection
CO2	Understand vapour compression refrigeration system and the effects of various parameters on its performance
CO3	Understand vapour absorption refrigeration system and compare it with vapour compression system.
CO4	Understand various air properties and psychrometric processe & various air conditioning systems
CO5	Evaluate cooling load for air conditioning systems used for various applications & Explain the principles of air distribution and duct design

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	3	3	1	3	1	1	1	1	1
CO2					3		3					
CO3	2	2	1	3	1	3	1	1	3	1	1	1
CO4	3	2	3	3	2	2	3	1	1	1	1	1
CO5	3	3	2	2	3	1	2	1	1	1	1	1

Course Contents

Unit 1: Air Refrigeration System [08 Hours]

Introduction, standard rating of refrigerating machine, coefficient of performance of refrigerator and heat pump. , Reversed Carnot cycle and its limitations, reversed Brayton cycle, application to air craft refrigeration. Bootstrap refrigeration cycle, reduced ambient air cooling system, Regenerative air cycle system Designation of refrigerant, selection of refrigerant, Desirable Properties, Primary and secondary refrigerants, azeotropes and its uses

Unit 2: Vapour Compression System [08 Hours]

Thermodynamics analysis, theoretical and actual cycle, Use of P-h and T-s diagram for problem solving, COP, Effect of evaporator and condenser temperature on cycle performance, Effects of suction superheating Liquid sub-cooling, liquid-vapour heat exchanger, estimation of compressor displacement, COPand power requirement, waste heat recover opportunities

Unit 3: Compound Vapour Compression System [08 Hours]

Multi-evaporator, multi-compressor systems, cascade system

Vapour Absorption System: Aqua-ammonia system, lithium bromide-water system, Electrolux refrigerator, comparison with vapour compression cycle (descriptive treatment only), use of enthalpy concentration, thermodynamic analysis, and capacity control, solar refrigeration system

Unit 4: Air Conditioning: [08 Hours]

Psychrometry, properties of moist air, Psychometric charts.Psychomeric processes, bypass factor Sensible and latent heat loads, SHF, GSHF, RSHF, All air system, all water system, unitary systems; window air-conditioner, split air-conditioners, refrigeration and air-conditioning controls

Unit 5: Air Conditioning Process Calculation [08 Hours]

Introduction to comfort air conditioning ,human comfort and comfort chart, Load calculation, outside conditions, indoor conditions, estimation of coil capacity required, evaporative cooling Principle of air distribution, duct design methods, friction chart, duct materials, methods of noise control

Texts books

1. Arora, C.P., Refrigeration and Air Conditioning, Tata McGraw Hills, New Delhi, SecondEdition, 2000.

2. Stoeker, W.F. and Jones, J.P., Principles of Refrigeration and Air Conditioning, McGraw Hill, New York, Second Edition, 1982.

References:

1. ASHRAE Handbook – Fundamentals and Equipment, 1993.

2. ASHRAE Handbook – Applications, 1961.

3. ISHRAE Handbook

4. NPTEL Lectures by Prof. RamGopal, IIT Kharagpur

5. Carriern Handbook

6. Jord R.C., and Priester, G.B., Refrigeration and Air Conditioning, Prentice - Hall of India Ltd., New Delhi, 1969.

7. Threlkeld, J.L., Thermal Environmental Engineering, Prentice Hall, New York, 1970.

Steam and Gas Turbine

BTMPE504B	PEC 2	Steam and Gas Turbine	3-0-0	3 Credits

Teaching Scheme:	Examination Scheme:
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	State Various properties of Steam, Draw P-V, T-s, H-s (Mollier) diagrams for Steam, Describe Theoretical steam turbine cycle.
CO2	Define and Understand Various Types of Design of Turbines.
CO3	Perform analysis of given steam and gas Turbine power plant (Efficiencies, Power Output, Performance)
CO4	Study and apply various Performance improvement Techniques in steam and gas Turbines
CO5	Assess factors influencing performance of thermal power plants,
CO6	Apply various maintenance procedures and trouble shootings to Turbines.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										
CO2	1	1										
CO3		2			2							
CO4	1				1	2	2					
CO5	1	2										
CO6	1	1		3								

Course Contents:

Unit 1: Introduction **[08 Hours]**

Properties of steam, Theoretical steam turbine cycle. The flow of steam through Impulse and Impulse–Reaction turbine blades

Unit 2: **[08 Hours]**

Vortex flow in steam turbines, Energy lines, State point locus, Reheat factor and Design procedure. Governing and performance of steam turbine

Unit 3: Gas Turbine **[08 Hours]**

Introduction, simple open cycle gas turbine, Actual Brayton cycle, Means of Improving the efficiency and the specific output of simple cycle,

Unit 4: Gas Turbine Cycle Modifications and Performance **[08 hours]**

Regeneration, Reheat, Intercooling, closed-cycle gas turbine, turbine velocity diagram and work done.

Unit 5: Turbine Cooling and maintenance **[08 Hours]**

Turbine blade cooling, material, protective coating, Performance of turbine, Application of turbine. Lubrication, cooling, fuel supply and control, Maintenance and trouble shooting.

Text-book:

1. W. J. Kearton, “Steam Turbine Theory and Practice”, ELBS.

References:

1. R. Yadav, “Steam and Gas Turbine”, Central Publishing Home, Allahabad.

Jack D. Mattingly, “Elements of Gas Turbine propulsion”, Tata McGraw Hill Publications

Automobile Engineering

BTAPE504D	PEC2	Automobile Engineering	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Identify the different parts of the automobile.
CO2	Explain the working of various parts like engine, transmission, clutch, brakes etc.,
CO3	Demonstrate various types of drive systems.
CO4	Apply vehicle troubleshooting and maintenance procedures.
CO5	Analyze the environmental implications of automobile emissions. And suggest suitable regulatory modifications.
CO6	Evaluate future developments in the automobile technology.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										
CO2	1	2		2		1						
CO3	1	1		1	1							
CO4	2			3	1							
CO5							2					
CO6												

Course Contents:

Unit 1: Introduction [08 Hours]

Vehicle specifications, Classifications, Main components of automobile and articulated vehicles; Engine-cylinder arrangements, Power requirements, Tractive efforts and vehicle performance curves.

Unit 2: Front Axle and Steering System [08 Hours]

Functions of front axle, Types of front axle, Construction, Stub axle and Wheel bearing, Front wheel steering Geometry – castor, Camber, King pin inclination, toe-in, toe-out, Centre point Steering, Self-returning property, Adjusting and checking of front wheel geometry, Ackerman and Davis steering linkages, Steering system layout, Steering gear boxes.

Unit 3: Vehicle Safety Systems [08 Hours]

Introduction, Electronic stability program system operation, overview, rollover mitigation system overview, active safety and passive safety, latest trends in traffic system for improved road safety, head restraints, introduction to the type of safety glass and their requirements, types of different mirrors and their location.

Unit 4: Wheels and Tyres [08 Hours]

Basic requirements of wheels and tyres, Types of road wheels, Construction of wheel assembly, wheel balancing, Tyre construction, material, types, tubeless, cross ply radial type, tyre sizes and designation, Aspect ratio, tyre trade pattern, tyre valve, Tyre inflation pressure, safety precautions in tyres, Tyre rotation and matching, Types of Tyre wear and their causes, Selection of tyres under different applications, tyre retreating hot and cold, factors affecting tyre performance.

Unit 5: Electrical Systems [08 Hours]

Construction, operation and maintenance of lead acid batteries, Battery charging system, Principle and operation of cutout and regulators, Starter motor, Bendix drive, Solenoid drive, Magneto-coil and solid stage ignition systems, Ignition timing.

Vehicle Testing and Maintenance

Need of vehicle testing, Vehicle tests standards, Different vehicle tests, over hauling, Engine tune up, Tools and equipment for repair and overhauling, Pollution due to vehicle emissions, Emission control system and regulations.

Texts:

1. Kripal Singh, “Automobile Engineering”, Vol. I and II,Standard Publishers.
2. G. B. S. Narang, “Automobile Engineering”, DhanpatRai and Sons.

References:

1. Joseph Heitner, “Automotive Mechanics”, East-West Press.
2. W. H. Crouse, “Automobile Mechanics”, Tata McGraw Hill Publishing Co.
3. “Motor Vehicles”, Newton, Steed and Garrot, 13th Edition, Butterworth London
4. “Vehicle and Engine Technology”, Heisler, Second Edition SAE International Publication.
5. “Advanced Vehicle Technology”, Heisler,Second Edition SAE International Publication.
6. “The Automotive Chassis”, J. Reimpell H. Stoll, J.W. Betzler, SAE International Publication.
7. Newton, Steed &Garrot, “Motor Vehicles”, 13th Edition, Butterworth London
8. A. W. Judge, “Modern Transmission”, Chapman & Hall Std., 1989

9. Chek Chart, “Automatic Transmission”, A Harper & Raw Publications
10. J. G.Giles, “Steering, Suspension & Tyres”, – Lliffe Book Ltd., London
11. W. Steed, “Mechanics of Road Vehicles”, Lliffe Book Ltd
12. Heisler, “Vehicle and Engine Technology”, Second Edition, SAE International Publication

Open Elective-I

Solar Energy

BTMOE505A	OEC1	Solar Energy	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Describe measurement of direct, diffuse and global solar radiations falling on Horizontal and inclined surfaces.
CO2	Analyze the performance of flat plate collector, air heater and concentrating type Collector.
CO3	Understand test procedures and apply these while testing different types of collectors.
CO4	Study and compare various types of thermal energy storage systems.
CO5	Analyze payback period and annual solar savings due to replacement of conventional Systems.
CO6	Design solar water heating system for a few domestic and commercial applications.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1											
CO2	1	2				1						
CO3	2			1	1		2					
CO4	1	1										
CO5		2			1							
CO6			2	3		1	1					

Course Contents

Unit 1: Solar Radiation **[08 Hours]**

Introduction, spectral distribution, solar time, diffuse radiation, Radiation on inclined surfaces, measurement of diffuse, global and direct solar radiation.

Unit 2: Liquid Flat Plate Collectors **[08 Hours]**

Introduction, performance analysis, overall loss coefficient and heat transfer correlations, collect or efficiency factor, collect or heat removal factor, testing procedures.

Unit 3: Solar Air Heaters **[08 Hours]**

Introduction, types of air heater, testing procedure.

Unit 4: Concentrating Collectors **[08 Hours]**

Types of concentrating collectors, performance analysis

Unit 5: Thermal Energy Storage and Economic Analysis **[08 Hours]**

Introduction, sensible heat storage, latent heat storage and thermo chemical storage

Solar Pond: Solar pond concepts, description, performance analysis, operational problems.

Economic Analysis Definitions, annular solar savings, payback period.

Text-books

1. J. A. Duffie, W. A. Beckman, “Solar Energy Thermal Processes”, John Wiley, 1974.
2. K. Kreith,J. F. Kreider, “Principles of Solar Engineering”, Tata McGrawHill Publications, 1978.

References:

1. H. P. Garg, J. Prakash, “Solar Energy: Fundamentals and Applications”, Tata McGraw Hill Publications, 1997.
2. S. P. Sukhatme, “Solar Energy Principles of Thermal Collection and Storage”, Tata McGrawHill Publications, 1996.

Renewable Energy Sources

BTMOE505B	OEC1	Renewable Energy Sources	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Explain the difference between renewable and non-renewable energy
CO2	Describe working of solar collectors
CO3	Explain various applications of solar energy
CO4	Describe working of other renewable energies such as wind, biomass , nuclear

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	3		2	3	3	3	2	2		2
CO2	1	1	3	1	2	3	3	3	2	2		2
CO3	2	1	1				3	2		1		2
CO4	3	3			2	3	3	2				1

Course Contents

Unit 1: Solar Energy **[08 Hours]**

Energy resources, Estimation of energy reserves in India, Current status of energy conversion Spectral distribution, solar geometry, Attenuation of solar radiation in Earth's atmosphere, Measurement of solar radiation, Properties of opaque and transparent surfaces.

Unit 2: Solar Collectors **[08 Hours]**

Flat Plate Solar Collectors: Construction of collector, material, selection criteria for flat plate collectors, testing of collectors, Limitation of flat plate collectors, Introduction to ETC.

Concentrating type collectors: Types of concentrators, advantages, paraboloid, parabolic trough, Heliostat concentrator, Selection of various materials used in concentrating systems, tracking.

Unit 3: Solar Energy Applications **[08 Hours]**

Air/Water heating, Space heating/cooling, solar drying, and solar still, Photo-voltaic conversion.

Unit 4: Wind Energy and Biomass **[08 Hours]**

Introduction to wind energy, Types of wind mills, Wind power availability, and wind power development in India. Evaluation of sites for bio-conversion and Introduction to biomass resources,Location of plants, Biomass conversion process

Unit 5: Other Renewable Energy Sources **[08 Hours]**

Tidal, Geo-thermal, OTEC, hydro-electric, Nuclear energy

Text-books

1. Chetan singh Solanki, "Renewable Energy Technologies" ,Prentice Hall of India, 2008.

References:

1. S. P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", Tata McGraw Hill Publications, New Delhi, 1992.
2. G. D.Rai, "Solar Energy Utilization", Khanna Publisher, Delhi, 1992.

Human Resource Management

BTMOE505C	OEC1	Human Resource Management	3-0-0	3 Credits

Teaching Scheme:	Examination Scheme:
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Describe trends in the labor force composition and how they impact human resource management practice.
CO2	Discuss how to strategically plan for the human resources needed to meet organizational goals and objectives.
CO3	Define the process of job analysis and discuss its importance as a foundation for human resource management practice
CO4	Explain how legislation impacts human resource management practice.
CO5	Compare and contrast methods used for selection and placement of human resources.
CO6	Describe the steps required to develop and evaluate an employee training program
CO7	Summarize the activities involved in evaluating and managing employee performance.
CO8	Identify and explain the issues involved in establishing compensation systems.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1					2						1	
CO2											3	
CO3										2		
CO4								2		2		
CO5									2	3		
CO6										1		3
CO7										2	2	
CO8											2	

Course Contents

Unit 1: Introduction to Human Resource Management [08 Hours]

Concept of management, concept of human resource management, personnel to human resource management, human resource e-management model, important environmental influences like government regulations, policies, labor laws and other legislation. Acquisition of human resources: Human resource planning, Demand for man power, Weaknesses of manpower planning, job analysis, job specification, recruitment sources, recruitment advertising, the selection process, selection devices, equal opportunities: Indian and foreign practices, socializing the new employee

Unit 2: Development of Human Resources [08 Hours]

Employee Training and Management Development: Training, Training and Learning, Identification of training needs, training methods, Manager Development, Methods for developing managers, evaluating training effectiveness.

Career Development: Concept of career, value of effective career development, external versus internal dimensions to a career, career stages, linking career dimensions with stages

Unit 3: Motivation of Human Resources [08 Hours]

Definition of motivation, Nature and Characteristics of Motivation, Theories of motivation: as low's Need Hierarchy Theory, Drucker Theory, Likert Theory, Herzberg Two Factor theory, McClelland Theory, McGregor Theory X and Y etc., psychological approach. Job Design and Work Scheduling: Design, Scheduling and Expectancy Theory, Job characteristics model, job enrichment, job rotation, work modules, flex-time, new trends in work scheduling.

Unit 4: Performance Appraisal [08 Hours]

Performance appraisal and expectancy theory; appraisal process, appraisal methods, factors that can destroy appraisal. Rewarding the Productive Employee: Rewards and expectancy theory, typesof rewards, qualities of effective rewards, criterions for rewards.

Unit 5: Maintenance of Human Resources and Labor Relations [08 Hours]

Compensation Administration: Concept of Compensation Administration, Job evaluation, Pay structures, Incentive's compensation plans. Benefits and Services Benefits: Something for everybody, Services, Trends in benefits and services. Discipline: Concept of Discipline, types of discipline problems, general guidelines, disciplinary action, employment-at-will doctrine, disciplining special employee group Safety and Health: safety programs, health programs, stress, turn out.

Labor Relations: Unions, Major labor legislation, goals of group representation. Collective Objectives, scope, participants of collective bargaining, process of collective bargaining, trends collective bargaining Research and the future: What is research? Types of research, hyresearch in human resource management, Secondary sources: where to look it up, Primary sources: relevant research methods, current trends and implications for human resource management.

Text-books

1. David A. DeCenzo, Stephen P. Robbins, "Personnel/Human Resources Management", Prentice Hall of India Pvt. Ltd, 3rd edition,2002.

2. Trevor Bolton, "An Introduction to Human Resource Management", Infinity Books, 2001.

References:

1. Ellen E.Kossek, "Human Resource Management–Transforming the Workplace", Infinity Books, 2001.

2. G. S. Batra, R. C. Dangwal, "Human Resource Management New Strategies",Deep and Deep Publications Pvt. Ltd., 2001.

3. D. M. Silvera, "HRD: The Indian Experience", New India Publications, 2nd edition, 1990.

CAD CAM CIM Lab

BTMACL 506	PCC 12	CAD CAM CIM Lab	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 6 hrs/batch	Continuous Assessment: 60 Marks External Exam: 40 Marks

List of Practical's/Experiments/Assignments:

1. To Create and Draft any two 2-D models using any one of the Graphic Package like AutoCAD, Catia, Creo Unigraphics.etc.
2. To Create and Draft any two 3-D models using any one of the Graphic Package like AutoCAD, Catia, Creo Unigraphics.etc.
3. Building two composite assemblies consisting of at least five components using using any Graphic Package
4. Developing and executing a part program for contouring on NC milling machine.
5. Developing and executing a part program for NC lathe machine.
6. Developing and executing a part program for point to point on NC drilling machine.
7. Assignment on FMS system.
8. Assignment on CIM and CAPP.

Machine Design –I Lab

BTMACL 507	PCC 13	Machine Design-I Lab	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 6 hrs/batch	Continuous Assessment: 60 Marks External Exam: 40 Marks

List of Practical's/Experiments/Assignments

1. The term work shall consist of 01 design projects based on syllabus of Machine Design-I.

   Design project shall consist of 2 full imperial size sheets-one involving assembly drawings with a part list and overall dimensions and other sheet involving drawings of individual components. Manufacturing tolerances, surface finish symbols and geometric tolerances should be specified, wherever necessary, so as to make it a working drawing.

   Make the Project full on Autocad or on any 3D Design software print the full sheet on A3 size paper.

2. A design report giving all necessary calculations for the design of components and assembly should be submitted in a separate file. Sheets for one of the projects will be drawn using AutoCAD and computer print outs using plotter of the same will be attached along with the design report.

3. At least two assignments based on topics of syllabus of Machine Design-I.

Heat Transfer Lab

BTMACL 508	PCC 14	Heat Transfer lab	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 6 hrs/batch	Continuous Assessment: 60 Marks External Exam: 40 Marks

List of Practical's/Experiments/Assignments (Any eight)

1. Determination of thermal conductivity of a metal rod.
2. Determination of thermal conductivity of insulating powder.
3. Determination of conductivity of a composite slab.
4. Temperature is distribution on a fin surface.
5. Determination of film heat transfer coefficient for natural convection.
6. Determination of film heat transfer coefficient for forced convection.
7. Determination of heat transfer coefficient for cylinder in cross flow in forced convection.
8. Performance of Double pipe Heat Exchanger/Shell and Tube Heat Exchanger.
9. Determination of emissivity of a metal surface.
10. Determination of Stefan-Boltzman's constant.
11. Determination of critical heat flux.
12. Calibration of measuring instruments pressure gauge, thermocouple, flow-meter etc.

IT – 2 Evaluations

BTMI408 (IT – 2)	PROJ-2	IT – 2 Evaluation	1 Credit

Teaching Scheme:	**Examination Scheme:**
Lecture: --	Continuous Assessment: -- Mid Semester Exam: -- End Semester Exam: 100 Marks

Semester – VI

Applied Hydraulics, Pneumatics and their controls

BTMAC601	PCC 15	Applied Hydraulics, Pneumatics and their controls	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Identify symbols in pneumatic and hydraulic ckts for designing fluid ckts..
CO2	Make calculations in designing hydraulic and pneumatic ckts . for special industrial applications
CO3	Obtain different control actions for pneumatic and hydraulic systems
CO4	Design and simulate the Hydraulic, Pneumatic, Electro-Hydraulic and Electro-Pneumatic circuits using software and experimentation.
CO5	Apply knowledge of hydraulics and pneumatics in industries and day today's life.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2							1
CO2	3	3	1	1	2							1
CO3	2	1	1	2	2							1
CO4	1	1	3	2	2							1
CO5	2	2	3	1	2							1

Course Contents

Unit 1: **[08 Hours]**

Introduction: Global fluid power Scenario , Basic system of Hydraulics-Major advantages and disadvantages, Principles of Hydraulic Fluid power, Hydraulic Symbols, Electrical Elements used in hydraulic circuits. Hydraulic Oils, Fluid Properties and Filter: Types, Properties, physical characteristics & functions of hydraulic Oils, Classification- Mineral based, Fire resistant& Biodegradable Oils, Filters, Contaminations, location of filter.

Unit 2 : **[08 Hours]**

Hydraulic Pumps, Motors and Actuators: Classification of hydraulic pumps, Gear Pumps, Vane Pumps, Piston Pumps, Axial piston pumps, Hydraulic motors, Linear and Rotary Actuators, Hydrostatic Transmission Systems. Hydraulic Valves and Hydraulic system Accessories: Direction control valves, Pressure control valves, Flow control valves, Non-return valves, Reservoirs, Accumulators, Heating & cooling devices, Hoses.

Unit 3 : **[08 Hours]**

Design of hydraulic circuits: Basic hydraulic circuits, Industrial hydraulic circuits, Power losses in flow control circuits.

Unit 4: **[08 Hours]**

Introduction to Pneumatics: Basic Requirements for Pneumatic System, Applications. Air Compressor and Service Unit: Types & Selection criteria for Air Compressors, Air receiver, Pipeline Layout, Air filter, Pressure regulator and Lubricator (FRL unit).

Unit 5: **[08 Hours]**

Cylinders, Motors and Valves: Types of Pneumatic Cylinders & Air motors, Cushion assembly, mounting Arrangements, Pneumatic Direction control valves, Quick exhaust, Time delay Shuttle and Twin pressure valves. Pneumatic circuits: Basic pneumatic circuits, Development of single Actuator Circuits, Development of multiple Actuator Circuits, Cascade method for sequencing.

Reference Books:

1. S R Majumdar, Oil Hydraulic Systems, Tata McGraw-Hill
2. S R Majumdar, Pneumatic Systems Tata McGraw-Hill
3. John Pippenger & Taylor Hicks, Industrial Hydraulics McGraw-Hill
4. Anthony Esposito, Fluid Power Prentice Hall
5. Andrew Parr, Hydraulics & Pneumatics Jaico Publications

Machine Design - II

BTMC 602	PCC 16	Machine Design - II	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Define function of bearing and classify bearings.
CO2	Understanding failure of bearing and their influence on its selection.
CO3	Classify the friction clutches and brakes and decide the torque capacity and friction disk parameter.
CO4	Select materials and configuration for machine element like gears.
CO5	Design of elements like gears, belts for given power rating

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1						1				1
CO2	3	2		1		1		1		1		1
CO3	1	1				1		1		1		1
CO4	3	3	2	1		2		1		1		1
CO5	1	1				1		1		1		1

Course Contents

Unit 1 Rolling Contact Bearings **[08 Hours]**

Types, Static and dynamic load carrying capacities, Stribeck's Equation, Equivalent load, load and life relationship, selection of bearing life, Load factor, selection of bearing from manufacturer's catalogue, Taper roller bearings and their selection, Cyclic loads and speeds, Design for probability of survival other than 90% Lubrication and mountings of rolling contact bearings.

Unit 2 Spur Gear **[08 Hours]**

Gear drives, Classification of gears, Law of gearing, Terminology of spur gear, Standard system of gear tooth force analysis, gear tooth failures, Selection of materials Constructional, Number of teeth, Face with, Beam strength equation, Effective load on gear tooth, Estimation of module based on beam strength. Design for maximum power capacity, Lubrication of gears.

Helical Gears: Terminology, Virtual number of teeth, Tooth proportions, Force analysis, Beam strength equation, and Effective load on gear tooth Wear strength equation.

Unit 3 Bevel Gears **[08 Hours]**

Types of bevel gears, Terminology of straight bevel, force analysis, Beam and Wear strength, Effective load on gear tooth.

Worm Gears: Terminology, Proportions, Force analysis, Friction in worm gears, Vector method, Selection of materials, Strength and wear rating, Thermal considerations

Unit 4 Belt and Flywheel **[08 Hours]**

Flat and V-belts, Geometric relationship, analysis of belt tensions,condition for maximum power, Selection of flat and V-belts from manufacturer's catalogue, Adjustment of belt tensions. Roller chains, Geometric relationship, polygonal effect.

Flywheel: Introduction, types of flywheel, stresses in disc and armed flywheel.

Unit 5 Brakes, Clutches **[08 Hours]**

Types of clutches, torque capacity, single and multi-plate clutches, cone clutch, centrifugal clutch, friction materials. Types of brakes, energy equation, block with shoe brake, pivoted brake with long shoe, internalexpanding shoe brake, thermal considerations.

Text-books:

1. V. B. Bhandari, "Design of machine Elements", Tata McGraw Hill Publications, NewDelhi,1998
2. R. L. Nortan, "Machine Design: An Integrated Approach", Pearson Education.

References:

1. J.E.Shigley, C.Mischke, " Mechanical Engineering Design", Tata McGraw Hill Inc, NewYork,6th edition, 2003.
2. R. C. Juvinall, K. M. Marshek, "Fundamentals of Machine Component Design", John Wiley &Sons, Inc, New York, 2002.

Elective-III

Machine Tool Design

BTMPE603C	PEC 3	Machine Tool Design	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: Machine design and Manufacturing processes-I

Course Outcomes: At the end of the course, students will be able to:

CO1	Understand basic motion involved in a machine tool.
CO2	Design machine tool structures for conventional and CNC machines.
CO3	Design and analyze system for specified speeds and feeds.
CO4	Understand control strategies for machine tool operations.
CO5	Design of rotary and linear drive for machine tools.
CO6	Analyze machine tool structure for design accuracy.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	1	1				1	1	1
CO2	3	1	3	1	2	1	1		1	1	1	1
CO3	2	1	2	1	1	1			1	1	1	1
CO4	2	1	1	1	1	1	1			1	1	1
CO5	3	1	3	1	1	1	1		1	1	1	1
CO6	2	1	2	1	1	1	1		1	1	1	1

Course Contents

Unit 1: Introduction **[08 Hours]**

Kinematics of different types of machine tools, selection of cutting conditions and tools, calculations of cutting force on single point and multipoint tools, hole machining, calculation of power, accuracy requirements and standards.

Unit 2: Design of Rotary Drives **[08 Hours]**

Design of spindle drives, AC motors with stepped drive, DC and AC variable speed drive motor characteristics and selection, principle of speed controllers, timing belts and other types of transmission belting, closed loop operation of mail drives, rotary indexing drives.

Unit 3: Design of Feed Drives **[08 Hours]**

Feed drive using feed boxes, axes feed drive of CNC drives, DC and AC servomotors, characteristics controllers and their selection, Ball screws and friction guide ways, linear motion systems, design calculation of drives, closed loop operations of feed drive, linear indexing drives.

Unit 4: Control Elements **[08 Hours]**

Single and multi-axis CNC controllers, hydraulic control, Pneumatic control limit switches, proximity switches, sequencing control using hardwired and PLC systems.

Design of machine tool structures: Static and dynamic stiffness, dynamic analysis of cutting process, stability, forced vibration, ergonomics and aesthetics in machine tool design.

Unit 5: Design of Spindle and Spindle Supports and Design of Special Purpose Machines **[07 Hours]**

Function of spindles, design requirements, standard spindle noses, designcalculation of spindles, bearing selection and mounting.

Finite elements analysis of machine tool structures: Examples of static, dynamic and thermal analysis and optimization of typical machine tool structure like column and using a finiteelement analysis package.

Design of Special Purpose Machines

Modular design concepts, standard modules, example of design of typical SPM with CNC, transfer machines.

Text-books

1. N. K. Mehta, "Machine Tool Design", Tata McGraw Hill Book Co., 1991.
2. P.C. Sharma, "A Textbook of Machine Tools and Tool Design", S. Chand & Co. Ltd., 1 January 2005.
3. Sen and Bhattacharya, "Principles of Machine Tools", 1 Jan 2009.
4. Yoram Koren, "Computer control of manufacturing systems", Tata McGraw Hill Education, 2009.

References:

1. Aacherkan, "Machine Tool Design", Vol. I and Vol. III, Mir Publishers, Moscow,1970.
2. W. L. Cheney, "Details of Machine Tool Design (Classic Reprint)", Forgotten Books, 20 Sep 2016.
3. Central Machine Tool Institute, "Machine Tool Design Handbook", Tata McGraw Hill Education, 1st Edition, 16 June 2001.
4. Nicholas Lisitsyn, Alexis V Kudryashov, Oleg Trifonov, Alexander Gavryusin, N Acherkan, Nicholas Weinstein, "Machine Tool Design", Vol. I, University Press of the Pacific, 20 April 2000.

Engineering Metrology and Quality Control

BTMPE603D	PEC 3	Engineering Metrology and Quality Control	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Identify techniques to minimize the errors in measurement
CO2	Identify methods and devices for measurement of length, angle, and gear and thread parameters, surface roughness and geometric features of parts.
CO3	Choose limits for plug and ring gauges.
CO4	Explain methods of measurement in modern machineries
CO5	Select quality control techniques and its applications
CO6	Plot quality control charts and suggest measures to improve the quality of product and reduce cost using Statistical tools.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				3								2
CO2		2	2		2							
CO3			2	3	2							
CO4						3						
CO5	1					2		3	3		3	2
CO6	1					2		3	3		2	2

Course Contents

Unit 1 Measurement Standard and Comparators [08 Hours]

Measurement Standard, Principles of Engineering Metrology, Line end, wavelength, Traceability of Standards. Types and Sources of error, Alignment, Slip gauges and gauge block, Linear and Angular Measurement (Sine bar, Sine center, Autocollimator, Angle Décor and Dividing head), Calibration. Comparator: Mechanical, Pneumatic, Optical, Electronic (Inductive), Electrical (LVDT).

Unit 2 Interferometry and Limits, Fits, Tolerances [08 Hours]

Principle, NPL Interferometer, Flatness measuring of slip gauges, Parallelism, Laser Interferometer, Surface Finish Measurement: Surface Texture, Measuring Surface Finish by Stylus probe, Tomlinson and Talysurf, Analysis of Surface Traces: Methods.

Design of Gauges: Types of Gauges, Limits, Fits, Tolerance; Terminology for limits and Fits. Indian Standard (IS 919-1963) Taylor's Principle.

Unit 3 Metrology of Screw Thread [08Hours]

Gear Metrology: Gear error, Gear measurement, Gear Tooth Vernier; Profile Projector, Tool marker's microscope. Advancements in Metrology: Co-ordinate Measuring Machine, Universal Measuring Machine, Laser in Metrology.

Unit 4 Introduction to Quality and Quality Tools [08 Hours]

Quality Statements, Cost of Quality and Value of Quality, Quality of Design, Quality of Conformance, Quality of Performance, Seven Quality Tools: Check sheet, Flow chart, Pareto analysis, cause and effect diagram, scatter diagram, Brain storming, Quality circles.

Unit 5 Total Quality Management and Statistical Quality Control [08 Hours]

Quality Function Deployment, 5S, Kaizan, Kanban, JIT, Poka yoke, TPM, FMECA, FTA, Zero defects. Statistical Quality Control: statistical concept, Frequency diagram, Concept of Variance analysis,Control chart for variable & attribute, Process Capability.

Acceptance Sampling**:** Sampling Inspection, sampling methods.Introduction to ISO 9000**:** Definition and aims of standardizations, Techniques of standardization, Codification system.

Text-books

1. I. C. Gupta, "Engineering Metrology", Dhanpatand Rai Publications, New Delhi, India.
2. M. S. Mahajan, "Statistical Quality Control", Dhanpat and Rai Publications.

References:

1. R. K. Jain, "Engineering Metrology", Khanna Publications, 17th edition, 1975.
2. K. J. Hume, "Engineering Metrology", McDonald Publications, 1st edition, 1950.
3. A. W. Judge, "Engineering Precision Measurements", Chapman and Hall, London, 1957.
4. K. L. Narayana, "Engineering Metrology", Scitech Publications, 2nd edition.
5. J. F. Galyer, C. R. Shotbolt, "Metrology for Engineers", Little-hampton Book Services Ltd., 5th edition, 1969.
6. V. A. Kulkarni, A. K. Bewoor, "Metrology & Measurements", Tata McGraw Hill Co. Ltd., 1st edition, 2009.

7. AmitavaMitra, “Fundamental of Quality Control and Improvement”, Wiley Publication.
8. V. A. Kulkarni, A. K. Bewoor, “Quality Control”, Wiley India Publication, 01st August, 2009.
9. Richard S. Figliola, D. E. Beasley, “Theory and Design for Mechanical Measurements”, Wiley India Publication.
10. E. L. Grant, “Statistical Quality Control”, Tata McGraw Hill Publications.
11. J. M. Juran, “Quality Planning and Analysis”, Tata McGraw Hill Publications.

E-Vehicles

BTAPE603E	E-Vehicles	PEC 3	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Understand EV history, current issues, trends, concept, technologies, and compare EVs with IC engines.
CO2	Describe EV configurations, including fixed/variable gearing, single/multiple motor drives, in-wheel drives, and analyze EV parameters.
CO3	Discuss EV propulsion systems, classify EV motors, compare their suitability, and explain power electronics and control systems.
CO4	Analyze DC and induction motor drives, including torque-speed characteristics and control strategies, and describe different inverter types.
CO5	Discuss battery and ultracapacitor types and characteristics, explain conductive and inductive charging methods, and describe charging infrastructure.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	3		2	1						1
CO2	1	1	2		1	1						2
CO3	2	2	1		1							1
CO4	1	3	2		3	1						1
CO5	1	3	1		1							3

Course Contents

Unit 1: Introduction to EV: **[08 Hours]**

Past, Present & Feature of EV, Current Major Issues, Recent Development Trends, EV Concept, Key EV Technology, State-of-the Art EVs, Comparison of EV Vs IC Engine.

Unit 2: EV System: **[08 Hours]**

EV Configuration: Fixed & variable gearing, single & multiple motor drive, In-wheel drives

EV Parameters: Weight, size, force, energy & performance parameters.

Unit 3: EV Propulsion: **[08 Hours]**

Electric Motor: Choice of electric propulsion system, block diagram of EV propulsion system, concept of EV Motors, single motor and multi-motor configurations, fixed & variable geared transmission, In- wheel motor configuration, classification of EV motors, Electric motors used in current vehicle applications, Recent EV Motors, Comparison of Electirc Motors for EV applications Required Power Electronics & Control: Comparison of EV power devices, introduction to power electronics converter, four quadrant DC chopper, three-pase full bridge voltage fed inverter, soft-switching EV converters, comparison of hard-switching and soft-switching converter, three-phase voltage-fed resonance dc link inverter, Basics of Microcontroller & Control Strategies

Unit IV: EV Motor Drive: **[08 Hours]**

DC Motor: Type of wound-field DC Motor, Torque speed characteristics DC-DC Converter, Two quadrants DC Chopper, and two quadrant zero voltage transition converter- fed dc motor drive, speed control of DC Motor.

Induction Motor Drive: Three Phase Inverter Based Induction Motor Drive, Equal Area PWM, Three Phase Auxiliary resonant snubber (ARS) Inverter Type (ZVC & ZCS), Single Phase ARS Inverter Topology, Speed Control of Induction Motor, FOC, Adaptive Control, Model Reference Adaptive Control (MARS), Sliding mode Control.

Unit V: Energy Sources & Charging: **[08 Hours]**

Different Batteries and Ultracapacitors, Battery characteristics (Discharging &Charging) Battery Chargers: Conductive (Basic charger circuits, Microprocessor based charger circuit.Arrangement of an off-board conductive charger, Standard power levels of conductive chargers, Inductive (Principle of inductive charging, Soft-switching power converter for inductive charging), Battery indication methods.

Charging Infrastructure: Domestic Charging Infrastructure, Public Charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move-and-charge zone.

References:

1. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University PressInc., New York 2001
2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
3. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
4. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003

Elective-IV

Process Equipment Design

BTMPE604A	PEC 4	Process Equipment Design	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Understand the factors influencing design of pressure vessel
CO2	Calculate thickness and thickness variation for cylindrical storage tank
CO3	Estimation of thickness for thin and thick wall pressure vessels
CO4	Design of flange and gasket selection for cylindrical pressure vessels
CO5	Selection of various blade and baffle arrangement for agitators
CO6	Design of support for horizontal and vertical vessel

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1		1			1	1	1				1
CO2	2	2	1			1	1	1				1
CO3	2	2	2			1	1	1				1
CO4	2	2	2			1	1	1				1
CO5	2	2	1			1	1	1				1
CO6	2	2	2			1	1	1				1

Course Contents

Unit 1:Design Considerations for Pressure Vessel [08 Hours]

Selection of type of vessel, Methods of fabrication, Effect of fabrication methods, various criteria in vessel design, Economic considerations, Types of process equipment, Constructional requirement and applications. Fabrication and testing, Inspection and non-destructive testing of equipment.

Unit 2: Storage Vessel [08 Hours]

Design methods of atmospheric storage vessel: storage of fluids, storage of non-volatile liquids, storage of volatile liquids, storage of gases, Optimum tank proportion, Bottom design, Shell design, Wind girder for open top tank, Rub curb angle, Self-supported roof, Design of rectangular tank

Unit 3 Pressure Vessel [08 Hours]

Unfired process vessel with internal and external pressure, Operating condition, Selection of material, Design condition, Stresses, Design criteria, Design of shell subjected to internal and external pressure, Cylindrical vessel under combined loading,

Design of heads and closures: flat head and formed heads for vessel. Design consideration for rectors and chemical process vessels. Flange facings, Gaskets, Design of flanged joint, Flange thickness, and Blind flanges.

Unit 4 High Pressure Vessel [08 Hours]

Design of thick walled high-pressure vessel, Constructional features, Materials for high-pressure vessels, Multilayer vessel with shrink fit construction, Thermal expansion for shrink fitting, stress in multi shell or shrink fit construction, autofrettage, Pre-stressing. Tall vessels and their design, Stress in shell, Determinations of longitudinal stresses, Longitudinal bending stresses due to eccentric loads, Determination of resultant longitudinal stresses.

Unit 5 Agitated Vessel and Support for Pressure Vessel [08 Hours]

Type of agitators, Baffling, Power requirement for agitation, Design based on torque and bending moment, Design based on critical speed, Blade design, Hub and key design, Stuffing box and gland design, Turbine agitator design,

Support for Pressure Vessel

Bracket or lug support: Thickness of the base plate, Thickness of web (gusset) plate, Column support for bracket base plate for column or leg support. Skirt Support: Skirt design, Skirt bearing plate, and Anchor bolt design, Design of bolting chair. Saddle Support: Longitudinal bending moment, Stresses in shell at saddle.

Text-books

1. V. V. Mahajani, S. B. Umarji, “Process Equipment Design”, Macmillan Publisher India Ltd.
2. L. E. Brownell, E. H. Young, “Process equipment design”, John Wiley and Sons.
3. C. Bhattacharya, “Introduction to process Equipment Design”.

Reference Book:

1. Dennis Moss, “Pressure Vessel Design Manual”, Elsevier.
2. John F. Harvey, “Theory and Design of Pressure Vessels”, CBS Publication.

Product Life Cycle Management

BTMPE604B	PEC 4	Product Life Cycle Management	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Outline the concept of PLM.
CO2	Illustrate the PDM system and its importance.
CO3	Illustrate the product design process.
CO4	Build the procedure for new product development.
CO5	Classify and compare various technology forecasting methods.
CO6	Outline the stages involved in PLM for a given product.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1				1						1	
CO2	1				1		1				1	
CO3	1		1		1							
CO4	1		1		1						1	
CO5	1				1		1					
CO6	1				1				1			1

Course Contents

Unit 1: Introduction and strategies to PLM [08 Hours]

Need for PLM, opportunities and benefits of PLM, different views of PLM, components of PLM, phases of PLM, PLM feasibility study, PLM visioning, Industrial strategies, strategy elements, its identification, selection and implementation, change management for PLM.

Unit 2: Product Data Management (PDM) [08 Hours]

Human resources in product lifecycle, Information, Standards, Vendors of PLM Systems and Components, PDM systems and importance, reason for implementing a PDM system, financial Justification of PDM, barriers to PDM implementation

Unit 3: Product Design [08 Hours]

Engineering design, organization and decomposition in product design, product design process, methodical evolution in product design, concurrent engineering, design for 'X' and designcentral development model. Strategies for recovery at end of life, recycling, human factors in product design. Modeling and simulation in product design.

Unit 4: New Product Development [08 Hours]

Structuring new product development, building decision support system, Estimating market opportunities for new product, new product financial control, implementing new product development, market entry decision, launching and tracking new product program, Concept of redesign of product

Unit 5: Technology Forecasting and PLM Software and Tools [08 Hours]

Future mapping, invocating rates of technological change, methods of technology forecasting such as relevance trees, morphological methods and mission flow diagram, combining forecast of different technologies, uses in manufacture alternative.

PLM Software and Tools

Product data security. Product structure, workflow, Terminologies in workflow, The Link between Product Data and Product Workflow, PLM applications, PDM applications.

Text-books/References:

1. Grieves, Michael, "Product Lifecycle Management", Tata McGraw-Hill, 2006, ISBN 007145230330.
2. Antti Saaksvuori, Anselmi Immonen, "Product Life Cycle Management", Springer, 1st edition, 2003.
3. Stark, John, "Product Lifecycle Management: Paradigm for 21stCentury Product Realization", Springer-Verlag, 2004.
4. Fabio Giudice, Guido La Rosa, "Product Design for the environment-A life cycle approach", Taylor & Francis, 2006.
5. Robert J. Thomas, "NPD: Managing and forecasting for strategic processes".

Finite Element Method

BTMPE604C	PEC 4	Finite Element Method	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Understand the basic principle of Finite element methods and its applications
CO2	Use matrix algebra and mathematical techniques in FEA
CO3	Identify mathematical model for solution of common engineering problem
CO4	Solve structural , thermal problems using FEA
CO5	Derive the element stiffness matrix using different methods by applying basic mechanics laws
CO6	Understand formulation for two and three dimensional problems

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1		1				1		1	1
CO2	2	3	2	1	2	1		1			2	1
CO3	3	2	2	1	1				1		2	1
CO4	3	3	2	1	2		1		1		2	1
CO5	3	1	1		1		1				2	1
CO6	1	1	1						1		1	1

Course Contents

Unit 1: Introduction **[08 Hours]**

Finite element analysis and its need, Advantages and limitations of finite element analysis (FEA), FEA procedure.

Unit 2: Elements of Elasticity **[08 Hours]**

Stress at a point, Stress equation of equilibrium, 2-D state of stress, Strains and displacements, Stress-strain relationship for 2-D state of stress, Plane stress and plane strain approach.

Unit 3: Relevant Matrix Algebra **[08 Hours]**

Addition, subtraction and multiplication of matrices, Differentiation and integration of matrices, Inverse of a matrix, Eigen values and eigen vectors, Positive definite matrix, Gauss elimination.

Unit 4: One-Dimensional Problems **[08 Hours]**

Introduction, FE modeling, Bar element, Shape functions, Potential energy approach, Global stiffness matrix, Boundary conditions and their treatments, Examples.

Unit 5: Trusses and Frames and Two-dimensional Problems **[08 Hours]**

Introduction, Plane trusses, Element stiffness matrix, Stress calculations, Plane frames, examples.

Two-dimensional Problems

Introduction and scope of 2-D FEA, FE modeling of 2-D problem, Constant strain triangle, other finite elements (no mathematical treatment included), Boundary conditions.

Text-books

1. T. R. Chandrupatla, A.D. Belegundu, " Introduction to Finite Elements in Engineering", Prentice Hall of India Pvt. Ltd., 3rd edition, New Delhi, 2004.

2. P. Seshu, "A Textbook of Finite Element Analysis", Prentice Hall of India Pvt. Ltd., New Delhi,2003.

3. R. D. Cook, D. S. Malkus, M. E. Plesha, R. J. Witt, "Concepts and Applications of FiniteElement Analysis", John Wiley &Sons, Inc.

References:

1. K. J. Bathe, "Finite Element Procedures", Prentice Hall of India Pvt. Ltd., 2006.

Open Elective-II

Quantitative Techniques in Project Management

BTMOE605A	OEC 2	Quantitative Techniques in Project Management	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: Engineering Mathematics-I/II/III

Course Outcomes: At the end of the course, students will be able to:

CO1	Define and formulate research models to solve real life problems for allocating limited resources by linear programming.
CO2	Apply transportation and assignment models to real life situations.
CO3	Apply queuing theory for performance evaluation of engineering and management systems.
CO4	Apply the mathematical tool for decision making regarding replacement of items in real life.
CO5	Determine the EOQ, ROP and safety stock for different inventory models.
CO6	Construct a project network and apply CPM and PERT method.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	3	2				3	1	3	1
CO2	3	1	1	3	2				3	2	3	1
CO3	3	1	1	3	2				3	2	3	1
CO4	3	1	1	3	2	1			3	2	3	1
CO5	3	1	1	3	2	1			3	2	3	1
CO6	3	1	1	3	2	2			3	2	3	1

Course Contents

Unit 1: Introduction [08 Hours]

Introduction to Operations Research, Stages of Development of Operations Research, Applications of Operations Research, Limitations of Operations Research Linear programming problem, Formulation, graphical method, Simplex method, artificial variable techniques.

Unit 2: Assignment and Transportation Models [08 Hours]

Transportation Problem, North west corner method, Least cost method, VAM, Optimality check methods, Stepping stone, MODI method, Assignment Problem, Unbalanced assignment problems, Travelling salesman problem.

Unit 3: Waiting Line Models and Replacement Analysis [08 Hours]

Queuing Theory: Classification of queuing models, Model I (Birth and Death model) M/M/I (∞, FCFS), Model II - M/M/I (N/FCFS). Replacement Theory, Economic Life of an Asset, Replacement of item that deteriorate with time,Replacement of items that failed suddenly.

Unit 4: Inventory Models [08 Hours]

Inventory Control, Introduction to Inventory Management, Basic Deterministic Models, Purchase Models and Manufacturing Models without Shortages and with Shortages, Reorder level and optimum buffer stock, EOQ problems with price breaks.

Unit 5: Project Management Techniques and Time and Cost Analysis [08 Hours]

Difference between project and other manufacturing systems.Defining scope of a project, Necessity of different planning techniques for project managements, Use of Networks for planning of a project, CPM and PERT.

Time and Cost Analysis

Time and Cost Estimates: Crashing the project duration and its relationship with cost of project, probabilistic treatment of project completion, Resource allocation and Resource leveling.

Text-books

1. P. K. Gupta, D. S. Hira, "Operations Research", S. Chand and Company Ltd., New Delhi, 1996.
2. L. C. Jhamb, "Quantitative Techniques for managerial Decisions", Vol. I and II, Everest Publishing House, Pune, 1994.
3. N. D. Vohra, "Operations Research", Tata McGraw Hill Co., New Delhi.

References:

1. H. Taha, "Operations Research–An Introduction", Maxwell Macmillan, New York.
2. J. K. Sharma, "Operations Research–An Introduction", Maxwell Macmillan, New Delhi.
3. Harvey M. Wagner, "Principles of Operations Research with Applications to Managerial Decisions", Prentice Hall of India Pvt. Ltd., New Delhi, 2nd edition, 2005.
4. Rubin and Lewin, "Quantitative Techniques for Managers", Prentice Hall of India Pvt. Ltd.,New Delhi.

Energy Conservation and Management

BTMOE605C	OEC 2	Energy Conservation and Management	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Understand energy problem and need of energy management
CO2	Carry out energy audit of simple units
CO3	Study various financial appraisal methods
CO4	Analyse cogeneration and waste heat recovery systems
CO5	Do simple calculations regarding thermal insulation and electrical energy conservation

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	3		2	3			2	2		2
CO2	1	1	3	1	2	3			2	2		2
CO3	2	1	1							1		2
CO4	3	3			2	3						1
CO5			3			2						1

Course Contents

Unit 1: Introduction **[08 Hours]**

General energy problem, Energy use patterns and scope of conservation. Energy Management Principles: Need, Organizing, Initiating and managing an energy management program.

Unit 2: Energy Auditing **[08 Hours]**

Elements and concepts, Types of energy audits, Instrument used in energy auditing. Economic Analysis: Cash flows, Time value of money, Formula relating present and future cash flows-single amount, uniform series.

Unit 3: Financial Appraisal Methods **[08 Hours]**

Payback period, Net present value, Benefit-cost ratio, Internal rate of return, Life cycle costs/benefits. Thermodynamics of energy conservation, Energy conservation in Boilers and furnaces, Energy conservation in Steam and condensate system.

Unit 4: Cogeneration and Insulation and Heating **[08 Hours]**

Concept, Types of cogeneration systems, performance evaluation of a cogeneration system.Waste Heat Recovery: Potential, benefits, waste heat recovery equipment's.

Space Heating, Ventilation Air Conditioning (HVAC) and water heating of building,Transfer of heat, Space heating methods, Ventilation and air conditioning, Heat pumps, Insulation, Cooling load, Electric water heating systems, Electric energy conservation methods.

Insulation and Heating Industrial Insulation: Insulation materials, Insulation selection, Economical thickness of insulation. Industrial Heating: Heating by indirect resistance, direct resistance heating (saltbath furnace), and Heat treatment by induction heating in the electric arc furnace industry.

Unit 5: Energy Conservation in Electric Utility and Industry **[08 Hours]**

Energy costs and two part tariff, Energy conservation in utility by improving load factor, Load curve analysis, Energy efficient motors, Energy conservation in illumination systems, Importance ofPower factor in energy conservation, Power factor improvement methods, Energy conservation in industries

Text-books

1. Callaghan,"Energy Conservation".
2. D. L. Reeg,"Industrial Energy Conservation", Pergamon Press.

References:

1. T. L. Boyen, "Thermal Energy Recovery", Wiley Eastern.
2. L. J. Nagrath, "System Modeling and Analysis", Tata McGraw Hill Publications.
3. S. P. Sukhatme, "Solar Energy", Tata McGraw Hill Publication.

Wind Energy

BTMOE605D	OEC2	Wind Energy	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Understand historical applications of wind energy
CO2	Understand and explain wind measurements and wind data
CO3	Determine Wind Turbine Power, Energy and Torque
CO4	Understand and explain Wind Turbine Connected to the Electrical Network AC and DC
CO5	Understand economics of wind energy

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1							2	2	2	1		1
CO2		3	2	1	3	2	2	2	2			1
CO3	3	3	1	1	2	2	1					1
CO4	3	3		1								1
CO5	3	2	1									1

Course Contents

Unit 1: Introduction and Wind Measurements **[08 Hours]**

Historical uses of wind, History of wind electric generations

Wind Characteristics: Metrology of wind, World distribution of wind, Atmospheric stability, Wind speed variation with height, Wind speed statistics, Weibull statistics, Weibull parameters, Rayleigh and normal distribution.

Wind Measurements Biological indicators, Rotational anemometers, other anemometers, Wind direction.

Unit 2: Wind Turbine Power, Energy and Torque **[08 Hours]**

Power output from an ideal turbine, Aerodynamics, Power output from practical turbines, Transmission and generation efficiency, Energy production and capacity factor, Torque at constant speeds, Drive train oscillations, Turbine shaft power and torque at variable speeds.

Unit 3: Wind Turbine Connected to the Electrical Network **[08 Hours]**

Methods of generating synchronous power, AC circuits, the synchronous generator, per unit calculations, the induction machine, motor starting, Capacity credit features of electrical network

Unit 4: Wind Turbines with Asynchronous Electric Generators **[08 Hours]**

Asynchronous systems, DC shunt generator with battery load, Per unit calculation, Self-excitation of the induction generators, Single phase operation the induction generator, Field modulated generators, Roesel generator.

Asynchronous Load: Piston water pumps, Centrifugal pumps, Paddle wheel heaters, Batteries, Hydrogen economy, and Electrolysis cells.

Unit 5: Economics of Wind Systems **[08 Hours]**

Capital costs, Economic concepts, Revenues requirements, Value of wind generated electricity

Text-books

1. S. Ahmad, “Wind Energy: Theory and Practice”, Prentice Hall of India Pvt. Ltd.

References:

1. Garg L. Johnson, “Wind Energy Systems” Prentice Hall Inc., New Jersey, 1985.

2. Desire Le Gouriers, “Wind Power Plants: Theory and Design” Pergamon Press, 1982.

Applied Hydraulics and Pneumatics Lab

BTMACL606	PCC 17	Applied Hydraulics and Pneumatics lab	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 6 hrs/batch	Continuous Assessment: 60 Marks End Semester Exam: 40 Marks

List of Experiments: (Any Eight)

1. Graphical Symbol as per DIN-ISO: 1219
2. To understand working and construction of hydraulic components and basic circuits.
3. To understand working and construction of pneumatic components and basic circuits.
4. Speed control of Hydraulic cylinder through Throttle valve.
5. Speed control of Hydraulic cylinder through The Flow control valve in Bypass.
6. Flow control valve in Meter-in & Meter-out circuit.
7. To control Double acting pneumatic cylinder through 5/2 D.C. Valve.
8. To control Double acting pneumatic cylinder by 3/2 push button valves and Shuttle Valve.
9. To understand use of Logic element ‘OR’ gate and ‘AND’ gate
10. To understand use of Quick Exhaust & Flow control valve.
11. To illustrate the use of Time Delay valve with ‘OR’ gate and ‘AND’ gate
12. To illustrate pneumatic circuit involving two cylinders.
13. To control double acting cylinder through 5/2 solenoid operated D.C. valve and PLC Controller.

Major Equipment:

1. Hydraulic trainer
2. Pneumatic trainer

Machine Design II Lab

BTMACL607	PCC 18	Machine Design II Lab	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 6 hrs/batch	Continuous Assessment: 60 Marks End Semester Exam: 40 Marks

List of Practical's/Experiments/Assignments

1. The term work shall consist of 01 design projects based on syllabus of Machine Design-II. Design project shall consist of 2 full imperial sizes sheets-one involving assembly drawings with a part list and overall dimensions and other sheet involving drawings of individual components. Manufacturing tolerances, surface finish symbols and geometric tolerances should be specified, where ever necessary, so as to make it a working drawing Make the Project full on Autocad or on any 3D Design software print the full sheet on A3 size paper.

2. A design report giving all necessary calculations for the design of components and assembly should be submitted in a separate file. Sheets for one of the projects will be drawn using AutoCAD and computer printout using plotter of the same will be attached along with the design report.

3. At least two assignments based on topics of syllabus of Machine Design-II.

ELE - III Lab

BTMACL608	PEC 5	ELE - III	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 6 hrs/batch	Continuous Assessment: 60 Marks End Semester Exam: 40 Marks

Perform any Practical's/ Assignments on ELE– III as per instructions of the concern subject faculty.

B. Tech Seminar

BTMAS610	PROJ-4	Seminar	0-0-2	1 Credits

Teaching Scheme:	**Examination Scheme:**
Practical:2 hrs/week	Continuous Assessment: 60 Marks End Semester Exam: 40 Marks

Mini Project

BTMAP611	PROJ-5	Mini Project	0-0-2	1 Credits

Teaching Scheme:	**Examination Scheme:**
Practical: 2 hrs/week	Continuous Assessment: 60 Marks End Semester Exam: 40 Marks (Duration 03 hrs)

Students are expected to carry out a mini project under a project guide based on the chosen area. The project may be prototype/software based which may demonstrate Engineering application or community service. After completion the project work it is necessary that student should prepare a project report under the supervision of the assign guide and present before the committee.

IT-3

BTMAI 609 (IT-3)	PROJ-6	IT-3	1 Credits

Teaching Scheme:	**Examination Scheme:**
Field Training/Industrial Training (Minimum 4 weeks)	Credit Evaluate in SEM -VII

Semester – VII

Robotics and Industrial Automation

BTMAC701	PCC18	Robotics and Industrial Automation	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: Basic knowledge of mechanics, electronics, and control systems and Prior coursework in engineering or a related field.

Course Outcomes: At the end of the course, students will be able to:

CO1	To understand the fundamental principles of robotics and automation.
CO2	To learn about various types of robots and their applications in industry.
CO3	To study the design and control aspects of robotic systems.
CO4	To gain insights into the integration of automation in industrial processes.
CO5	To explore the latest advancements and future trends in robotics and industrial automation

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3				3						2	2
CO2	3						3		2	2	2	
CO3			3	3				2				
CO4		3				3	3	2				2

Course Contents

Unit 1: Introduction to Robotics and Industrial Automation [08 Hours]
Definition and history of robotics and automation, Overview of industrial applications, Benefits and challenges of automation, Coordinate systems and transformations, Forward and inverse kinematics

Unit 2: Robot Dynamics [08 Hours]
Newton-Euler and Lagrange methods, Dynamic modeling of robotic manipulators, Simulation of robot dynamics, Types of actuators: electric, pneumatic, hydraulic, Selection criteria for actuators, Sensor technologies: position, velocity, force, and vision sensors.

Unit 3: Robot Control Systems [08 Hours]
Open-loop and closed-loop control, PID control and advanced control strategies, Motion planning and trajectory generation, Robot programming languages (e.g., RAPID, KRL, V+).

Unit 4: Industrial Automation Systems [08 Hours]
Components of automation systems: PLCs, SCADA, and HMI, Automation system architecture and design, Communication protocols in automation, CNC machines and robotics in manufacturing, Assembly lines and robotic assembly, Automated material handling.

Unit 5: Safety and Standards in Robotics and Automation [08 Hours]
Safety standards and regulations, Risk assessment and mitigation, Human-robot collaboration and safety.

Textbooks and References:

1. **Primary Textbook**: "Introduction to Robotics: Mechanics and Control" by John J. Craig.
2. **Secondary Textbook**: "Automation, Production Systems, and Computer-Integrated Manufacturing" by Mikell P. Groover.
3. Additional readings and resources will be provided throughout the course.

Industrial Engineering and Management

BTHM702	HSSMC4	Industrial Engineering and Management	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Impart fundamental knowledge and skill sets required in the Industrial Management and Engineering profession, which include the ability to apply basic knowledge ofmathematics, probability and statistics, and the domain knowledge of IndustrialManagement and Engineering
CO2	Produce ability to adopt a system approach to design, develop, implement and innovate integrated systems that include people, materials, information, equipment and energy.
CO3	Understand the interactions between engineering, businesses, technological and environmental spheres in the modern society.
CO4	Understand their role as engineers and their impact to society at the national and global context.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1											2	1
CO2									2	2	2	
CO3								2				
CO4								2				2

Course Contents

Unit 1: Introduction **[08 Hours]**

Managing and managers, management- science, theory and practice, functions of management, evolution of management theory, contributions of Taylor, Fayol and others.

Planning: The nature and purpose of planning, objectives, strategies, policies and planning premises, decision making.

Organizing: The nature and purpose of organizing, departmentation, Line/ staff authority and decentralization, effective organizing and organizational culture.

Unit 2: Human Resource Management **[08 Hours]**

Staffing: Human resource management and selection, orientation, apprentice training and Apprentice Act (1961), performance appraisal and career strategy, job evolution and meritrating, incentive schemes.

Leading: Managing and human factor, motivation, leadership, morale, team building, and communication.

Controlling: The system and process of controlling control techniques, overall and preventive control.

Unit 3: Production/Operations Management **[08 Hours]**

Operations management in corporate profitability and competitiveness, types and characteristics of manufacturing systems, types and characteristics of services systems.

Operations planning and Control: Forecasting for operations, materials requirement planning, operations scheduling.

Unit 4: Design of Operational Systems **[08 Hours]**

Product/process design and technological choice, capacity planning, plant location, facilities layout, assembly line balancing, and perspectives on operations systems of the future.

Unit 5: Introduction to Industrial Engineering and Ergonomics **[08 Hours]**

Scope and functions, history, contributions of Taylor, Gibreth, Gantt and others.

Work Study and Method Study: Charting techniques, workplace design, motion economy principles.

Work Measurement: Stopwatch time study, micromotion study, predetermined time system (PTS), work sampling.

Ergonomics Basic principles of ergonomics

Concurrent Engineering: Producibility, manufacturability, productivity improvement.

Total Quality Management: Just in time (JIT), total quality control, quality circles, six sigma.

Text-books

1. H. Koontz, H. Weirich, “Essentials of Management”, Tata McGraw Hill book Co., Singapore, International Edition, 5th edition, 1990.
2. E. S. Buffa, R. K. Sarin, “Modern Production/Operations Management”, John Wiley and Sons, New York, International Edition, 8th edition, 1987.
3. P. E. Hicks, “Industrial Engineering and Management: A New Perspective”, Tata McGraw Hill Book Co., Singapore, International Edition, 2nd edition, 1994.

References:

1. J. L. Riggs, "Production Systems: Planning, Analysis and Control", John Wiley & Sons,New York, International Edition, 4th edition, 1987.
2. H. T. Amrine, J. A. Ritchey, C. L. Moodie, J. F. Kmec, "Manufacturing Organization and Management", Pearson Education, 6th edition, 2004.
3. International Labour Organization (ILO), "Introduction to Work Study", International Labour Office, Geneva, 3rd edition, 1987.

Elective-V

Additive Manufacturing

BTMAPE703A	PEC6	Additive Manufacturing	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes- At the end of the course, students will be able to:

CO1	Understand the importance of Additive Manufacturing
CO2	Classify the different AM processes
CO3	Design for AM processes
CO4	Understand the applications of AM
CO5	Differentiate the post processing processes

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	2	2					1
CO2	2	2	3	3	3	3	1					1
CO3	2	2	3	3	3		2					1
CO4	3	3	3	2	2	2	2					1
CO5	2	3	3	2	2	2	2					1

Course Contents

Unit 1: Introduction to Additive Manufacturing (AM) [08 Hours]

Introduction to AM, AM evolution, Distinction between AM and CNC machining, Advantages of AM.

AM process chain: Conceptualization, CAD, conversion to STL, Transfer to AM, STL file manipulation, Machine setup, build , removal and clean up, post processing.

Classification of AM processes: Liquid polymer system, discrete particle system, molten material systems, and solid sheet system.

Unit 2: Design for AM [08 Hours]

Motivation, DFMA concepts and objectives, AM unique capabilities, Exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers etc.

Unit 3: Guidelines for Process Selection [08 Hours]

Introduction, selection methods for a part, challenges of selection, example system for preliminary selection, production planning and control

Unit 4: AM Applications [08 Hours]

Functional models, Pattern for investment and vacuum casting, Medical models, art models, Engineering analysis models, Rapid tooling, new materials development, Bi-metallic parts, Re-manufacturing. Application examples for Aerospace, defense, automobile, Bio-medical and general engineering industries

Unit 5: Post Processing of AM Parts and Future Directions of AM [08 Hours]

Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques.

Future Directions of AM Introduction, new types of products, employment and digiproneurship.

Text-books

1. Chua Chee Kai, Leong Kah Fai, “Rapid Prototyping: Principles and Applications”, World Scientific, 2003.
2. Ian Gibson, David W. Rosen, Brent Stucker, “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2nd edition, 2010.

References:

1. Ali K. Kamrani, EmandAbouel Nasr, “Rapid Prototyping: Theory and Practice”, Springer, 2006.
2. D. T. Pham, S. S. Dimov, “Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling”, Springer, 2001.
3. Andreas Gebhardt, “Understanding Additive Manufacturing”, Hanser Publishers, 2011.

Process Control and Automation

BTMAPE703B	PEC6	Process Control and Automation	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Course Outcomes: At the end of the course, students will be able to:

CO1	Understand process control hierarchies, derive theoretical models using transfer functions and state space, and develop time series models.
CO2	Understand the Feedback &Feed forward Control system in process Control
CO3	Understand Analyze and design multi-loop and multivariable control systems, mitigate process interactions using singular value analysis and tuning,
CO4	Discuss batch process control, plant-wide control design, instrumentation for process monitoring, and implement statistical process control.
CO5	Explain OPC, discuss environmental issues and sustainable development, and compare the performance of different types of control systems with examples.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									2
CO2	2	3	3									1
CO3	1	2	3									2
CO4	2	1	3									2
CO5	2	3	1									1

Course Contents

Unit 1 Process Modelling [08 Hours]

Introduction to Process control and process instrumentation-Hierarchies in process control systems-Theoretical models-Transfer function-State space models-Time series models.

Unit 2 Feedback &Feed forward Control [08 Hours]

Feedback controllers-PID design, tuning, trouble shooting-Cascade control- Selective control loops-Ratio control-Control system design based on Frequency response Analysis-Direct digital design-Feed forward and ratio control-State feedback control- LQR problem

Unit 3 Advanced process control [08 Hours]

Multi-loop and multivariable control-Process Interactions-Singular value analysis-tuning of multi loop PID control systems-decoupling control-strategies for reducing control loop interactions -Real-time optimization.

Unit 4 Model predictive control [08 Hours]

Batch Process control-Plant-wide control & monitoring- Plant wide control design- Instrumentation for process monitoring-Statistical process control.

Unit 5 Introduction to Fuzzy Logic in Process Control [08 Hours]

Introduction to OPC-Introduction to environmental issues and sustainable development relating to process industries. Comparison of performance different types of control with examples.

Text Books:

1. Seborg, D.E., T.F. Edgar, and D.A. Mellichamp, Process Dynamics and Control, John Wiley, 2004
2. Johnson D Curtis, Instrumentation Technology, (7th Edition) Prentice Hall India, 2002.
3. Bob Connel, Process Instrumentation Applications Manual, McGraw Hill, 1996.

References Books:

4. Edgar, T.F. & D.M. Himmelblau, Optimization of Chemical Processes, McGraw Hill Book Co, 1988.
5. Macari Emir Joe and Michael F Saunders, Environmental Quality Innovative Technologies
6. Patrick Bouwman,Fundamentals of Process Control: Principles and Concepts, International Society of Automation (12 July 2022)

IOT in Automation

BTMAPE703C	PEC6	IOT in Automation	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Course Outcomes: At the end of the course, students will be able to:

CO1	Discover key IIoT concepts including identification, sensors, localization, wireless protocols, data storage and security
CO2	Explore IoT technologies, architectures, standards, and regulation
CO3	Realize the value created by collecting, communicating, coordinating, and leveraging the data from connected devices
CO4	Examine technological developments that will likely shape the industrial landscape in the future
CO5	Understand how to develop and implement own IoT technologies, solutions, and applications

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3		3							1
CO2	1	1	2		3							1
CO3	3	2	1		3							2
CO4	3	2	2		2							2
CO5	2	3	3		2							1

Course Contents

Unit 1 **[08 Hours]**

Introduction & Architecture: What is IIoT and the connected world? the difference between IoT and IIoT, Architecture of IIoT, IOT node, Challenges of IIOT. Fundamentals of Control System, introductions, components, closed loop & open loop system.

Unit 2 **[08 Hours]**

IIOT Components: Introduction to Sensors (Description and Working principle): What is sensor? Types of sensors, working principle of basic Sensors -Ultrasonic Sensor, IR sensor, MQ2, Temperature and Humidity Sensors (DHT-11). Digital switch, Electro Mechanical switches.

Unit 3 **[08 Hours]**

Communication Technologies of IIoT: Communication Protocols: IEEE 802.15.4, ZigBee, Z Wave, Bluetooth, BLE, NFC, RFID Industry standards communication technology (LoRAWAN, OPC UA, MQTT), connecting into existing Modbus and Profibus technology, wireless network communication.

Unit 4 **[08 Hours]**

Visualization and Data Types of IIoT: Front-end EDGE devices, Enterprise data for IoT, Emerging descriptive data standards for IIoT, Cloud database, Cloud computing, Fog or Edge computing. Connecting an Arduino/Raspberry pi to the Web: Introduction, setting up the Arduino/Raspberry pi development environment, Options for Internet connectivity with Arduino, Configuring your Arduino/Raspberry pi board for the IoT.

Unit 5 **[08 Hours]**

Retrieving Data: Extraction from Web: Grabbing the content from a web page, Sending data on the web, Troubleshooting basic Arduino issues, Types of IoT interaction, Machine to Machine interaction (M2M). Control & Supervisory Level of Automation: Programmable logic controller (PLC), Real-time control system, Supervisory Control & Data Acquisition (SCADA). HMI in an automation process, ERP & MES.

TEXT BOOKS:

1. The Internet of Things in the Industrial Sector, Mahmood, Zaigham (Ed.) (Springer Publication)
2. Industrial Internet of Things: Cyber manufacturing System, Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer Publication)
3. Industrial IoT Challenges, Design Principles, Applications, and Security by Ismail Butun (editor)

REFERENCE BOOK:

1. IoT Automation: Arrowhead Framework, CRC Press.

Robotics and Industrial Automation Lab

BTMACL706	PCC19	Robotics and Industrial Automation	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 6 hrs/batch	Continuous Assessment: 60 Marks End Semester Exam: 40 Marks

List of Practical's/Experiments/Assignments (Any Six)

1. Introduction to Robot Kinematics and Dynamics
2. Safety Protocols in Robotics Lab
3. Basics of Robot Programming Languages (e.g., RAPID, KRL)
4. Writing and Executing Simple Robot Programs
5. To study Force and Torque Sensing in Robotics
6. To study Introduction to HMI Design
7. To study Introduction to PLC Hardware and Software

Mini-project 2

BTMAP 707	PROJ 7	Mini-project 2	0-0-6	3 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 6 hrs/batch	Continuous Assessment: 60 Marks End Semester Exam: 40 Marks

1. BTMAP708 Mini Project and BTMAP801/ BTMAI801 Project /Internship are independent and allotment will also be done independently in respective semester.
2. BTMAP708 Mini Project will be done in-house only.
3. Evaluation of both will be done independently as per the time schedule in AC.
4. In case student(s) choose in-house project, it may be an extension of the Mini Project, however, Mini Project should be completed in all respect in semester VII itself.

IT-3 Evaluation

BTMI 609	PROJ 7	IT-3 Evaluation	1 Credit

Practical Scheme:	**Examination Scheme:**
Lecture: --	Continuous Assessment: -- Mid Semester Exam: -- End Semester Exam: 100 Marks

SEMESTER VIII

Project- 8

BTMP801/ BTMI801	Project work/ Internship	PROJ-7	10 Credits

Teaching Scheme:	**Examination Scheme:**
Practical: 24 hrs/week	Continuous Assessment: 60 Marks Mid Semester Exam: -- End Semester Exam: 40 Marks

ANNEXURE

Sr. NO	Course Code	Course Name	Duration in weeks	Institute Offering Course	Name of Professor
1	BTMEC801A	Fundamentals of Automotive Systems	12 Weeks	IITM	Prof. C. S. Shankar Ram
2	BTMEC801B	Introduction to Machine Learning	12 Weeks	IITM	Prof. Balaraman Ravindran
3	BTMEC801C	Machinery Fault Diagnosis and Signal Processing	12 Weeks	IITKGP	Prof. Amiya Ranjan Mohanty
4	BTMEC801D	Product Design and Manufacturing	12 Weeks	IITK	Prof. J.Ramkumar Prof. Amandeep Singh
5	BTMEC801E	Advanced Robotics	12 Weeks	IITK	Prof. Ashish Dutta

SEM	I	II	III	IV	V	VI	VII	VIII	TOTAL
CREDITS	18	19	21	20	22	22	21	18	161

Dr. Babasaheb Ambedkar Technological University, Lonere

Sr. No.	NAME OF SUBJECT AS PER CURRICULUM COURSE	COURSE CODE	SEMESTER	SWAYAM / NPTEL Course	Name of Institute offering course	Relevance %	DURATION OF COURSE
1	Engineering Mathematics-III	BTBS30	III	Engineering Mathematics-I	IITKGP	40	12 Weeks
2	Fluid Mechanics	BTMC302		Fluid Mechanics	IITKGP	70	8 Weeks
				Fluid dynamics and Turbomachines	IITM	40	8 Weeks
3	Thermodynamics	BTMC303		Concepts Of thermodynamics	IITKGP	90	12 Weeks
				Concepts of Thermodynamics	IITKGP		
				Engineering Thermodynamics	IITK		
4	Material Science and Metallurgy	BTMES304		Material Science and Engineering	IITR	70	8 Weeks
				Introduction to Material Science and Engineering	IITD	70	12 Weeks
				Corrosion – Part- I	IITK	70	8 Weeks
5	Manufacturing Process- I	BTMAC304	IV	Manufacturing Process - I	IITR	60	12
				Fundamental of Manufacturing Process	IITR	60	12
6	Theory of Machine-I	BTMC402		Theory of Machines	IITK	70	Module
				Kinematics of Machines	IITM	70	Module
7	Basics Human and Rights	BTHM403		Human Rights in India	O.P. Jindal Global University	60	15 Weeks
				Exploring Human Values: Visions of Happiness and Perfect Society - Web course	IITK	40	Module
8	Strength of Materials	BTMES404		Strength of Materials	IITKGP	80	12 Weeks
9	Applied Thermodynamics	BTMPE405A		Concepts of Thermodynamics	IIT KGP	70	12 weeks
				Applied Thermodynamics	IIT Madras		Module
10	Numerical Method in Engineering	BTMPE405B		Numerical Methods for Engineers	IIT Madras	80	12 weeks
				Numerical methods	IITR	80	4 Weeks
11	Sheet Metal Engineering	BTMPE405C		Metal Forming	IITR	70	Module
12	Fluid Machinery	BTMPE405D		Fluid Machanics	IITKGP	70	8 Weeks
				Fluid dynamics and turbomachines	IITM	60	8 Weeks
13	Heat Transfer	BTMC501	V	Heat and Mass Trasnfer	IITM	70	Module
14	Machine Design – I	BTMC502		Design of Machine Elements I	IITGP	70	12 Weeks
15	Theory of Machine - II	BTMC503		Design of Machine Elements I -	IITKGP	30	Module
				Dynamics of Machines	IITK	30	Module
16	Metrology and Quality Control	BTMPE504D		Engineering Metrology	IITJ	60	12 Weeks
17	Refrigeration and air-conditioning	BTMPE504A		Refrigeration and air-conditioning	IITR	70	8 Weeks
				Refrigeration and air-conditioning	IIT KGP	70	Module
18	Steam and Gas Turbine	BTMPE504B		Steam Power Engineering	IITG	30	8 Weeks
				IC Engines and Gas Turbines	IITG	50	12 Weeks
19	Engineering Tribology	BTMPE504D		Tribology	IITD	70	Module
20	Automobile Design	BTAPE504A		Fundamentals of manufacturing Process	IITR	20	12 Weeks
				Basics Of Finite Element Analysis – I	IITK		8 Weeks

21	Automobile Engineering	BTAPE504D		Fundamentals of Automotive Systems	IITM	40	12 Weeks
22	Solar Engineering	BTMOE505A		Solar Engineering Technology -	IITKGP	40	Module
23	Renewable Energy Sources	BTMOE505B		Technologies For Clean And Renewable Energy Production	IITR	30	8 Weeks
24	Human Resource Management	BTMOE505C		Human resource development	IIT KGP	40	12 Weeks
25	Product Design Engineering	BTMOE505D		Product Design Using Value Engineering	IITR	30	4 weeks
				Product Design and Innovation	IITG	30	4 Weeks
				Product Design and Manufacturing	IITK	30	8 Weeks
				Product Design and Development	IITR	30	4 Weeks
26	Manfacturing Process - II	BTMC601		Manufacturing Process - II	IITKGP	30	Module
				Manufacturing Process - II	IITKGP	30	Module
27	Machine Design- II	BTMC602		Machine Design II	IIT Madras	80	Module
28	IC Engines	BTMPE603A		IC Engines and Gas Turbines	IITG	40	12 weeks
29	Mechanical Vibration	BTMPE603B		Introduction to Mechanical Vibration	IITR	70	8 Weeks
			VI	Principles Of Vibration Control	IITK	40	4 Weeks
30	Machine Tool Design	BTMPE603C		Metal Cutting And Machine Tools	IITKGP	60	4 weeks
				Computer Numerical Control Of Machine Tools And Processes	IITGP	60	4 Weeks
31	Automobile Body Design	BTAPE603D		Advances in welding and joining technologies	IIT Guwahati	30	8 Weeks
				Welding Processes	IITM	30	12

							Weeks
32	E-Vehicle	BTAPE603E		Introduction to Hybrid and Electric Vehicles -	IITG	30	Module
33	Process Equipment Design	BTMPE604A		Equipment Design: Mechanical Aspects	IITR	60	4 weeks
34	Product Life Cycle Management	BTMPE604B		Product Designand Services	IITR	30	4 Weeks
				Management of New Products and Services	IITK	30	4 Weeks
35	Finite Element Method	BTMPE604C		Basics Of Finite Element Analysis – I	IIT Kanpur	55	8 Weeks
				Finite Element Method-Variational Method to Computer Programming	IIT Guwahati		12 Weeks
36	Robotics	BTMPE604D		Introduction to Robotics	IIT Madras	60	12 Weeks
				Mechanism and Robot Kinametics	IIT Kharagpur		8 Weeks
				Robotics	IIT Kharagpur		8 Weeks
37	Computational Fluid Dynamics	BTAPE604B		Computational Fluid Dynamics for Incompressible Flows	IITG	60	12 Weeks
38	Quantitative Techniques and Project Management	BTMOE605A		Introduction to Operation Research	IITR	60	8 Weeks
				Operation Management	IITM	40	12 Weeks
39	Nanotechnology	BTMOE605B	VI	Introduction to Mechanical Micro Maching	IITKGP	50	12 Weeks
40	Energy Conversation and Management	BTMOE605C		Energy Conservation And Waste Heat Recovery	IITKGP	50	12 Weeks

41	Wind Energy	BTMOE605D		Non Convectional Energy Resources	IITM	40	12 Weeks
				Non-Conventional Energy Resources	IITM	40	12 Weeks
42	Introduction to Probability Theory and Statics	BTMOE605E		Introduction To Probability And Statistics	IITM	50	04 weeks
43	Mechatronics	BTMC701	VII	Mechatronics And Manufacturing Automation	IITG	60	12 Weeks
44	Industrial Engineering and Management	BTHM702		Project Management for Managers	IITR	50	12 Weeks
				Principles of Industrial Engineering	IITR	50	12 Weeks
45	Design of Air Conditioning Systems	BTMPE703A		Refrigeration and Air Conditioning (Video Course)	Prof. Ravi Kumar	80	8 Weeks
				Refrigeration and Air Conditioning	IITKGP	90	12 Weeks
				RAC Product Design	IITD	80	8 Weeks
46	Biomechanics	BTMPE703B		Mechanics of Human Movement	IIT Madras	20	12 Weeks
47	Non-conventional Machining	BTMPE703C		Advanced Machining Processes	IIT Guwahati	50	8 Weeks
48	Advanced IC Engines	BTMPE703D		IC Engines and Gas Turbines	IIT Guwahati	40	12 Weeks
49	Additive Manufacturing	BTMPE703E		The Future of Manufacturing Business: Role of Additive Manufacturing	IIT Madras	10	8 Weeks
50	Surface Engineering	BTMPE703F		Fundamentals of Surface Engineering: Mechanisms, Processes and Characterizations	IIT Roorkee	20	12 Weeks
51	Processing of Polymers	BTMPE703G		Processing of Polymers and Polymer Composites	IIT Roorkee	70	8 Weeks
52	Entrepreneurship Development	BTMOE704B		Entrepreneurship Essentials	IIT Khargpur	70	12 Weeks
				Entrepreneurship	IIT Madras	50	12 Weeks
				Entrepreneurship Development	B.K. School of Business Management, Gujarat University	60	12 Weeks
				NOC-Entrepreneurship	IIT Madras	40	12 Weeks
53	Plant Maintenance	BTMOE704C	VII	Machinery fault diagnosis and signal Processing	IIT Kharagpur	15	12 Weeks
				Project Management	IIT Kanpur	10	8 Weeks
54	Engineering Economics	BTMOE705A		Engineering economics analysis	IIT Roorkee	60	8 Weeks
55	Biology for Engineers	BTMOE705B		NOC: Biology for engineers and other non-biologists	IIT Madras	90	4 Weeks
56	Intellectual Property Rights	BTMOE705C		Intellectual Property Rights	IIT Madras	70	11 Weeks
				NOC: Introduction on Intellectual Property to Engineers and Technologists	IIT Khakarpur	60	8 Weeks
Course Mapping with COURSERA Online Platform							

1	Engineering Mathematics-III	BTBS30	III	Introduction to Ordinary Differential Equations	Korea Advanced Institute of Science and Technology	20	9 Weeks
2	Fluid Mechanics	BTMC302		Fundamentals of Fluid Power	University of Minnesota	40	6 Weeks
				Fluid Properties	Georgia Institute of Technology	30	8 Weeks
3	Thermodynamics	BTMC303		Introduction to Thermodynamics: Transferring Energy from Here to There	University of Michigan	30	8 Weeks
				Statistical Thermodynamics Specialization	University of Colorodo Boulder	30	5 Weeks
4	Material Science and Metrallurgy	BTMES304		Materials Science: 10 Things Every Engineer Should Know	University of California, Davis	20	5 Weeks
				Material Behavior	Georgia Institute of Technology	20	5 Weeks
5	Manufacturing Process- I	BTMAC304		Manufacturing Processes Management	University at Buffalo	20	4 Weeks

6	Theory of Machine-I	BTMC402	IV	Engineering Systems in Motion	Dr. Wayne Whiteman	50	7 Weeks
7	Basics Human and Rights	BTHM403		Human Rights for Open Societies	Utrecht University	50	6 Weeks
8	Strength of Materials	BTMES404		Mechanics of Materials - I	Prof. Wayne Whiteman	40	3 Weeks
				Mechanics of Materials - II		40	5 Weeks
				Mechanics of Materials - III		40	4 Weeks
9	Applied Thermodynamics	BTMPE405A		Introduction to Thermodynamics	Prof. Margaret Wooldridge	40	8 Weeks
10	Numerical Method in Engineering	BTMPE405B		Introduction to Numerical Methods	Prof. Evgeni Burovski	60	7 Weeks
				Introduction to numerical analysis	National Research University Higher School of Economics	50	6 Weeks
11	Sheet Metal Engineering	BTMPE405C	IV	Creating Sheet Metal Parts	Autodesk	10	4 Weeks
12	Fluid Machinery	BTMPE405D		Fluid Properties	Georgia Institute of Technology	20	8 Weeks
13	Machine Design – I	BTMC502	V	Machine Design Part I	Dr. Kathryn Wingate	20	5 Weeks
14	Theory of Machine - II	BTMC503		Engineering Systems in Motion: Dynamics of Particles and Bodies in 2D Motion	Georgia Institute of Technology	20	7 Weeks
15	Metrology and Quality Control	BTMPE504D		Intellgent Machining	University at Buffalo	20	4 Weeks
16	Refrigeration and air-conditioning	BTMPE504A		Introduction to Thermodynamics: Transferring Energy from Here to There	Margaret Wooldridge	30	8 Weeks
17	Steam and Gas Turbine	BTMPE504C		Introduction to Thermodynamics: Transferring Energy from Here to There	University of Michigan	20	8 weeks
18	Solar Engineering	BTMOE505A		Solar Energy . Basic	Prof. Neal Abrams	20	5 Weeks
19	Renewable Energy Sources	BTMOE505B		Exploring Renewable Energy Schemes	Prof. Jorge Santiago-Aviles	40	6 Weeks
				Solar Energy Basic	Prof. Neal Abrams	20	5 Weeks

20	Human Resource Management	BTMOE505C		Human Resource Management: HR for People Managers Specialization	University of Minnesota	40	5 weeks
21	Product Design Engineering	BTMOE505D		New Product Development - develop your own new product	Avy Shtub Technion - Israel Institute of Technology	30	12 weeks
22	IC Engines	BTMPE603A		The Hardware of Our Internal Combustion Engines	Margaret Wooldridge University of Michigan	15	8 Weeks
23	Mechanical Vibration	BTMPE603B		Introduction to Basic Vibration	Prof. Yang-HannKim	25	5 Weeks
24	E-Vehicle	BTAPE603E	VI	Electric Vehicles and Mobility	École des	5	6 Weeks
					Ponts Paris Tech		
25	Product Life Cycle Management	BTMPE604B		New Product Development – develop your own new product	Technion – Israel Institute of Technology	30	10 Weeks
26	Finite Element MEthod	BTMPE604C		The Finite Element Method for Problems in Physics	University of Michigan	40	13 Weeks
27	Robotics	BTMPE604D		Robotics Specialization	University of Pennsylvania	40	6 Weeks
28	Computational Fluid Dynamics	BTAPE604B		Simulation and modeling of natural processes	University of Geneva	40	6 weeks
29	Quantitative Techniques and Project Management	BTMOE605A	VI	`Shortest Paths Revisited, N P-Complete Problems and What To Do About Them	Prof. Tim Roughgarden	20	4 Weeks
				Supply Chain Analytics Essentials	Yao Zhao	20	4 Weeks
30	Nanotechnology	BTMOE605B		Nanotechnology: A Maker's Course	Duke University	50	6 Weeks
				Nanotechnology and Nanosensors	Technion - Israel Institute of Technology	60	8 Weeks
31	Wind Energy	BTMOE605D		Wind Energy	Prof. Merete Badger	30	5 Weeks
32	Introduction to Probability Theory and Statics	BTMOE605E		Introduction to Probability and Data	Duke University	10	12 Hr
33	Mechatronics	BTMC701	VII	Embedding Sensors and Motors Specialization	University of Colorado Boulder	40	5 Months
34	Additive Manufacturing	BTMPE703E		Generative Design for Additive Manufacturing	Autodesk	5	4 Weeks
35	Surface Engineering	BTMPE703F		Methods of Surface Analysis	National Research Nuclear University, Russia	5	5 Weeks
36	Sustainable Development	BTMOE704A		The Age of Sustainable Development	Columbia University	85	4 Weeks
37	Entrepreneurship Development	BTMOE704B		Entrepreneurship 1: Developing the Opportunity	Wharton University of Pennsylyania	30	4 Weeks
				Entrepreneurship	The Chinese University of Hong Kong	40	4 Weeks

				Essentials of Entrepreneurship: Thinking & Action	University of California, Irvine	40	4 Weeks
38	Intellectual Property Rights	BTMOE705C		Introduction to Intellectual Property	R. Polk Wagner University of Pennsylvania	40	4 Weeks
				Intellectual Property Law Specialization	R. Polk Wagner University of Pennsylvania	30	4 Weeks

Course Mapping with EDx Online Platform							
1	Engineering Mathematics-III	BTBS30	III	Transfer Functions and the Laplace Transform	Massachusetts Institute of Technology	30	10 Weeks
2	Fluid Mechanics	BTMC302		AP® Physics 2 - Part 1: Fluids and Thermodynamics	Rice	20	5 Weeks
3	Material Science and Metrallurgy	BTMES304		Structure of Materials	MITX	10	16 Weeks
4	Manufacturing Process- I	BTMAC304	IV	Fundamental of Manufacturing Process	MITx	20	10 Weeks
5	Theory of Machine-I	BTMC402	IV	Mechanics: Kinematics and Dynamics	Prof. DeeptoChakrabarty	40	12 Weeks
6	Basics Human and Rights	BTHM403		Human Rights Defenders	Amnesty International	40	4 Weeks
7	Strength of Materials	BTMES404		Mechanical Behaviour of Materials	Prof. Loma J Gibson	40	4 Weeks
8	Applied Thermodynamics	BTMPE405A		Thermodynamics	IIT Bombay	30	12 Weeks
9	Sheet Metal Engineering	BTMPE405C		Fundamental of Manufacturing Process	MITx Massachusetts Institute of Technology	30	
10	Heat Transfer	BTMC501	V	Advanced Transport Phenomena	Delft University of Technology	20	6 Weeks
11	Refrigeration and air-conditioning	BTMPE504A		Thermodynamics	IIT Bombay	20	12 Weeks
12	Steam and Gas Turbine	BTMPE504C		Energy Supply Systems	Delft University of Technology	40	4 weeks
13	Engineering Tribology	BTMPE504D		Tribology	Masschusetts Institute of Technology	50	6 Weeks
14	Automobile Engineering	BTAPE504D		Automotive Engine Fundamentals	Tsinghua University	5	14 Weeks
15	Solar Engineering	BTMOE505A		Solar Energy	Delftx	20	8 Weeks
16	Renewable Energy Sources	BTMOE505B		Incorporating Renewable Energy in Electricity Grids	Imperial College , London	40	6 Weeks
17	Human Resource Management	BTMOE505C		People Management	IIMBx	20	6 Weeks
18	Product Design Engineering	BTMOE505D		Product Design: The Delft Design Approach	DelftX	20	7 Weeks
19	Manfacturing Process - II	BTMC601		Fundamentals of Manufacturing Processes	MITx	20	10 Weeks

20	IC Engines	BTMPE603A		Hybrid Vehicles	ChalmersX	10	6 Weeks
21	Mechanical Vibration	BTMPE603B		Mechanical Vibration	Open Edx	10	8 Weeks
22	Product Life Cycle Management	BTMPE604B		Lead the product life cycle from discovery to delivery	University of Maryland, College Park	10	20 Weeks
			VI	Project Management Life Cycle	Rochester Institute of Technology	10	10 Weeks
23	Finite Element Method	BTMPE604C		Finite Element Method (FEM) Analysis and Application	Tsinghua University	30	20 Weeks
24	Robotics	BTMPE604D		Robotics	Columbia University	60	7 Weeks
25	Computational Fluid Dynamics	BTAPE604B		A Hands-on Introduction to Engineering Simulations	Cornell University	40	6 Weeks
26	Quantitative Techniques and Project Management	BTMOE605A	VI	Operations Research: an Active Learning Approach	The Hongong Polytechnic University	30	6 Weeks
				The Basics of Transport Phenomena	Prof. Robert Mudde	20	7 Weeks
27	Nanotechnology	BTMOE605B		Nanotechnology: Fundamentals of Nanotransistors	Purdue University	20	4 Weeks
				Nanoscience and Technology	Purdue University	20	8 Weeks
28	Introduction to Probability Theory and Statics	BTMOE605E		Probability - The Science of Uncertainty and Data	Massachusetts Institute of Technology	40	10Week
29	Mechatronics	BTMC701	VII	Mechatronics Revolution: Fundamentals and Core Concepts	Guggenheim School of Aerospace Engineering	80	8 Weeks
30	Design of Air Conditioning Systems	BTMPE703A		Efficient HVAC Systems	Delft university of technology	60	5 Weeks
				Thermal Comfort in Buildings	Delft University of technology	50	5 Weeks
31	Surface Engineering	BTMPE703F		Surface Science: Methods of Surface Analysis	MEPhIx	10	8 Weeks
32	Sustainable Development	BTMOE704A		Age of Sustainable Development	SDG Academy	80	14 Weeks
33	Entrepreneurship Development	BTMOE704B		Entrepreneurship for Engineers	Delft university of Technology	30	8 Weeks
				Becoming an Entrepreneur	Massachusetts institute of Technology	40	6 weeks
				DO Your Venture: Entrepreneurship For Everyone	IIM Bangalore	50	6 weeks
				Marketing Management	IIM Bangalore	20	9 weeks