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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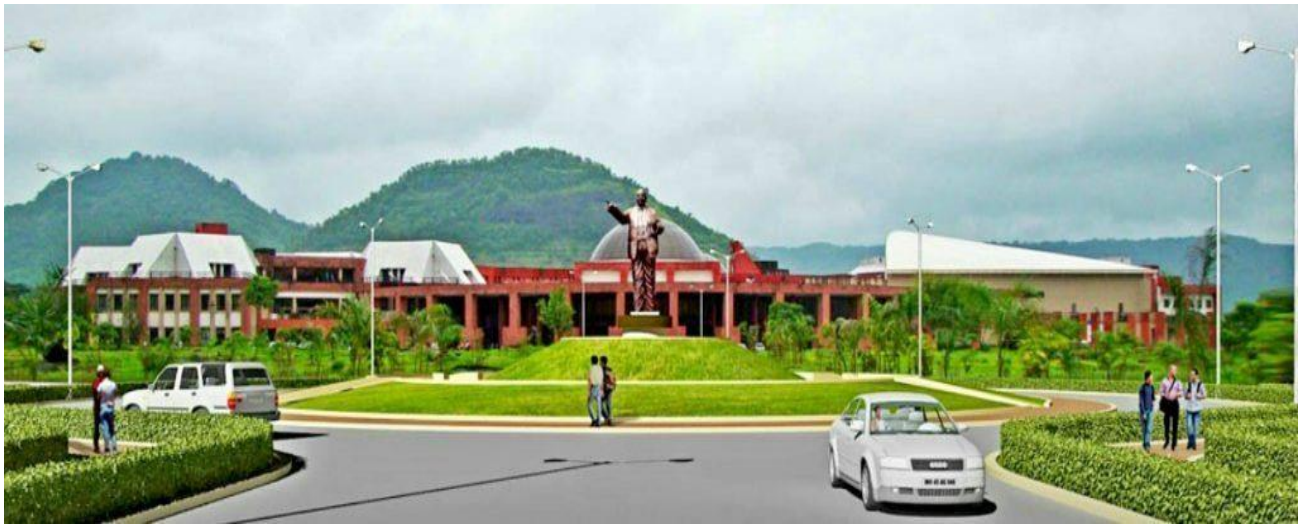
PROPOSED CURRICULUM

UNDER GRADUATE PROGRAMME

B.TECH

AUTOMOBILE ENGINEERING

WITH EFFECT FROM THE ACADEMIC YEAR 2020-2021.



Vision

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

Mission

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

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 automobile engineering including thermal, manufacturing and industrial systems to formulate design requirements.
PO3	Design, implement and evaluate automobile systems 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 mechanical 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. 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/PGprogramme 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.

   1.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.
2. PhD students can register for any of PG/PhD courses and the corresponding rules of evaluation will apply.

3. 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]	

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

1.	MidSemester Exam (MSE) Marks	20
2.	ContinuousAssesment Marks	20
3.	EndSemesterExamination(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,
'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 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 (upto 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. Eligibility Criteria for Majors

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. Eligibility Criteria for Minors

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*

DEPARTMENT OF AUTOMOBILE ENGINEERING

Bachelor of Technology in Automobile Engineering

.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
BTAC303	Thermodynamics & Heat Transfer	(3-1-0)4
BTACL305	Automotive Component Drawing and Computer Aided Drafting Lab	(0-0-4)2
BTACL306	Automobile Engineering Lab I	(0-0-6)3
BTAC401	Theory of Automotive Engines	(3-1-0)4

BTPC402	Theory of Machines	(3-1-0)4
BTACL406	Automobile Engineering Lab II	(0-0-6)3
BTPC501	Design of Machine Elements	(3-1-0)4
BTAC502	Automotive Chassis, Suspension & Transmission Systems	(3-1-0)4
BTAC503	Manufacturing Processes	(3-1-0)4
BTMC506	Applied Thermodynamics	(3-1-0)4
BTACL506	Automobile Engineering Lab III	(0-0-6)3
BTAC601	Automobile Air Conditioning, Electricals and Electronics	(3-1-0)4
BTAC602	Vehicle Dynamics, Emission and Control	(3-1-0)4
BTACL606	Automobile Engineering Lab IV	(0-0-6)3
BTAC701	Vehicle Performance and Testing	(3-1-0)4
BTACL706	Automobile Engineering Lab V	(0-0-6)3
Professional Elective Course (PEC)		
BTAPE405A	Automotive Materials	(3-0-0)3
BTAPE405B	Alternative Fuels for IC	(3-0-0)3
BTMPE405A	Numerical Methods in Engineering	(3-0-0)3
BTMPE405B	Sheet Metal Engineering	(3-0-0)3
BTMPE405C	Fluid Machinery	(3-0-0)3
BTAPE504A	Automobile Design	(3-0-0)3
BTAPE504B	Automobile Tribology	(3-0-0)3
BTAPE504C	Special Purpose Vehicles	(3-0-0)3
BTAPE504D	Automobile Engineering	(3-0-0)3
BTAPE603A	Vehicle Architecture and Packaging	(3-0-0)3
BTAPE603B	Computer Simulation of IC Engine Processes	(3-0-0)3
BTAPE603C	Automobile Body Design (Pre-requisite: Automobile Design)	(3-0-0)3
BTAPE603D	Vehicle Aerodynamics	(3-0-0)3
BTAPE603E	E Vehicles	(3-0-0)3
BTAPE603F	Design of Experiments	(3-0-0)3
BTAPE604A	Transport Management	(3-0-0)3
BTAPE604B	Computational Fluid Dynamics	(3-0-0)3
BTAPE604C	Ergonomics in Automotive Design	(3-0-0)3
BTAPE604D	Tractor and Farm Equipment	(3-0-0)3
BTAPE604E	Noise and Vibration	(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
BTAPE703A	Design & Manufacturing of Automotive Components	(3-0-0)3
BTAPE703B	Virtual Reality	(3-0-0)3
BTAPE703C	Actuation System	(3-0-0)3
BTAPE703D	Electric and Hybrid Vehicles	(3-0-0)3
BTAPE703E	Safety & Regulations (Automotive)	(3-0-0)3
BTAPE703F	Motor Insurance Practices	(3-0-0)3

BTMPE703B	Biomechanics	(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)4
BTMOE605B	Nanotechnology	(3-1-0)4
BTMOE605C	Energy Conservation and Management	(3-1-0)4
BTMOE605D	Wind Energy	(3-1-0)4
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
BTAI407 (Internship – 2)	IT – 2 Evaluation	(0-0-0) 1
BTAS607	B.Tech Seminar	(0-0-2)1
BTAP608	Mini Project	(0-0-2)2
BTAI609 (IT – 3)	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	BTAC401 Theory of Automotive Engines	BTPC501 Design of Machine Elements	BTAC601 Automobile Air Conditioning, Electricals and Electronics	BTAC701 Vehicle Performance and Testing	BTAP801/ BTAI801 Project work/ Internship
2	BTBS102 Engineering Physics	BTBS202 Engineering Chemistry	BTMC302 Fluid Mechanics	BTPC402 Theory of Machines	BTAC502 Automotive Chassis, Suspension & Transmission Systems	BTAC602 Vehicle Dynamics, Emission and Control	BTHM702 Industrial Engineering and Management	--
3	BTES103 Engineering Graphics	BTES203 Engineering Mechanics	BTAC303 Thermodynamics & Heat Transfer	BTHM403 Basic Human Rights	BTAC503 Manufacturing Processes	BTAPE603 **(Elective III)**	BTAPE703 / BTMPE703 **(Elective V)**	--
4	BTHM104 Communication Skills	BTES204 Computer Programming	BTMES304 Materials Science and Metallurgy	BTMES404 Strength of Materials	BTAPE504/ BTMPE504 **(Elective II)**	BTAPE604 / BTMPE604 **(Elective IV)**	BTMOE704 **(Open Elective III)**	--
5	BTES105 Energy and Environment Engineering	BTES205 Basic Electrical and Electronics Engineering	BTACL305 Automotive Component Drawing and Computer Aided Drafting Lab	BTAPE405 / BTMPE405 **(Elective I)**	BTMOE505 **(Open Elective I)**	BTMOE605 **(Open Elective II)**	BTMOE705 **(Open Elective IV)**	--
6	BTES106 Basic Civil and Mechanical Engineering	BTES206L Workshop Practice	BTACL306 Automobile Engineering Lab I	BTACL406 Automobile Engineering Lab II	BTMC 506 Applied Thermodynamics	BTACL606 Automobile Engineering Lab IV	BTACL706 Automobile Engineering Lab -V	--
7	BTBS107L Engineering Physics Lab	BTBS207L Engineering Chemistry Lab	BTES209P (IT – 1 Evaluation)	BTAI407 (IT – 2)	BTACL507 Automobile Engineering Lab III	BTAS607 B.Tech seminar	BTAI609 (IT – 3 Evaluation))	--
8	BTES108L Engineering Graphics Lab	BTES208L Engineering Mechanics Lab	Constitution of India	--	BTAI407 (IT – 2 Evaluation)	BTAP608 Mini Project		--
9	BTHM109L Communication Skills Lab	BTES219P (IT - 1)	--	--	Artificial Intelligence	BTAI609 (IT – 3)	-	--
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Course Structure for First Year (Group A)
B.Tech. in Automobile Engineering (w.e.f. 2020-21)

Semester I										
Course Category	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**				
			L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	**No. of Credits**
	Mandatory	***Induction Program***	***3-weeks duration in the beginning of the semester***							
BSC1	BTBS101	Engineering Mathematics- I	3	1	-	20	20	60	100	4
BSC2	BTBS102	Engineering Physics	3	1	-	20	20	60	100	4
ESC1	BTES103	Engineering Graphics	2	-	-	20	20	60	100	2
HSSMC1	BTHM104	Communication Skills	2	-	-	20	20	60	100	2
ESC2	BTES105	Energy and Environment Engineering	2	-	-	20	20	60	100	2
ESC3	BTES106	Basic Civil and Mechanical Engineering	2	-	-	50	-	-	50	Audit
BSC3	BTBS107L	Engineering Physics Lab	-	-	2	60	-	40	100	1
ESC4	BTES108L	Engineering Graphics Lab	-	-	3	60	-	40	100	2
HSSMC2	BTHM109L	Communication Skills Lab	-	-	2	60	-	40	100	1
		Total	**14**	**2**	**7**	**330**	**100**	**420**	**850**	**18**

Course Structure for First Year (Group A)
B.Tech in Automobile Engineering (w.e.f. 2020-21)

Semester II										
Course Category	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**				
			L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	**No. of Credits**
BSC4	BTBS201	Engineering Mathematics-II	3	1	-	20	20	60	100	4
BSC5	BTBS202	Engineering Chemistry	3	1	-	20	20	60	100	4
ESC5	BTES203	Engineering Mechanics	2	1	-	20	20	60	100	3
ESC6	BTES204	Computer Programming	3	-	-	20	20	60	100	3
ESC7	BTES205	Basic Electrical and Electronics Engineering	2	-	-	50	-	-	50	Audit
ESC8	BTES206L	Workshop Practice	-	-	4	60	-	40	100	2
BSC6	BTBS207L	Engineering Chemistry Lab	-	-	2	60	-	40	100	1
ESC9	BTES208L	Engineering Mechanics Lab	-	-	2	60	-	40	100	1
PROJ-1	BTES209P (IT– 1)	Field Training/Industrial Training (minimum of 4 weeks which can be completed partially in first semester and second Semester or in one semester itself)	-	-	-	-	-	-	-	To be evaluated in Sem III
	Mandatory	***NSS/NCC/Sports***	-	-	-	-	-	-	-	**Audit**
		Total	**13**	**3**	**8**	**310**	**80**	**360**	**750**	**18**

Course Structure for Semester III
B.Tech in Automobile Engineering(w.e.f. 2021-22)

Semester III										
Course Category	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**				**Credit**
			L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
BSC7	BTBS301	Engineering Mathematics – III	3	1	-	20	20	60	100	4
PCC 1	BTMC302	Fluid Mechanics	3	1	-	20	20	60	100	4
PCC 2	BTAC303	Thermodynamics& Heat Transfer	3	1	-	20	20	60	100	4
ESC10	BTMES304	Materials Science and Metallurgy	3	1	-	20	20	60	100	4
PCC 3	BTACL305	Automotive Component Drawing and Computer Aided Drafting Lab	-	-	4	60	-	40	100	2
PCC 4	BTACL306	Automobile Engineering Lab I	-	-	6	60	-	40	100	3
PROJ-1	BTES209P	IT – 1 Evaluation	-	-	-	-	-	100	100	1
		Constitution of India*								Audit
		Total	**12**	**4**	**10**	**200**	**80**	**420**	**700**	**22**

Course Structure for Semester IV
B.Tech. in Automobile Engineering (w.e.f. 2021-22)

Semester IV										
Course Category	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**				**Credit**
			L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
PCC 5	BTAC401	Theory of Automotive Engines	3	1	-	20	20	60	100	4
PCC 6	BTPC402	Theory of Machines	3	1	-	20	20	60	100	4
HSSMC3	BTHM403	Basic Human Rights	3	-	-	20	20	60	100	3
ESC11	BTMES404	Strength of Materials	3	1	-	20	20	60	100	4
PEC 1	BTAPE405 / BTMPE405	Elective-I	3	-	-	20	20	60	100	3
PCC7	BTACL406	Automobile Engineering Lab II	-	-	6	60	-	40	100	3
PROJ-2	BTAI407 (IT – 2)	Field Training/Industrial Training (minimum of 4 weeks which can be completed partially in the third and fourth semester or in one semester).	-	-	-	-	-	-	-	Credits to be evaluated in V Sem.
		Total	**15**	**3**	**6**	**160**	**100**	**340**	**600**	**21**

Sr.No	**Elective I: Subject code**	**Subject Name**
1	BTAPE405A	Automotive Materials
2	BTAPE405B	Alternative Fuels for IC
3	BTMPE405A	Numerical Methods in Engineering
4	BTMPE405B	Sheet Metal Engineering
5	BTMPE405C	Fluid Machinery

Course Structure for Semester V
B.Tech in Automobile Engineering (w.e.f. 2022-23)

Semester V										
Course Category	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**				**Credit**
			L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
PCC 8	BTPC501	Design of Machine Elements	3	1	-	20	20	60	100	4
PCC 9	BTAC502	Automotive Chassis,	3	1	-	20	20	60	100	4

		Suspension&Transmission Systems								
PCC 10	BTAC503	Manufacturing Processes	3	1	-	20	20	60	100	4
PEC 2	BTAPE504/ BTMPE504	Elective-II	3	-	-	20	20	60	100	3
OEC 1	BTMOE505	Open Elective-I	3	-	-	20	20	60	100	3
PCC 11	BTMC 506	Applied Thermodynamics	3	1	-	20	20	60	100	4
PCC12	BTACL507	Automobile Engineering Lab III	-	-	6	60	-	40	100	3
PROJ-2	BTAI408 (IT – 2)	IT – 2 Evaluation	-	-	-	-	-	100	100	1
		Artificial Intelligence*	3							3*
		Total	**18+ 3**	**4**	**6**	**180**	**120**	**500**	**800**	**26+3***

Elective II:

Sr.No	Subject code	Subject Name
1	BTAPE504A	Automobile Design
2	BTAPE504B	Automobile Tribology
3	BTAPE504C	Engines Special Purpose Vehicles
4	BTAPE504D	Automobile Engineering

Open Elective I:

Sr.No	Subject code	Subject Name
1	BTMOE505A	Solar Energy
2	BTMOE505B	Renewable Energy Sources
3	BTMOE505C	Human Resource Management
4	BTMOE505D	Product Design Engineering

Course Structure for Semester VI
B.Tech in Automobile Engineering (w.e.f. 2022-23)

Semester VI									
Course Category	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**				**Credit**
			L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
PCC 12	BTAC601	Automobile Air Conditioning, Electricals and Electronics	3	1	-	20	20	60	100	4
PCC 13	BTAC602	Vehicle Dynamics, Emission and Control	3	1	-	20	20	60	100	4

PEC 3	BTAPE603	Elective-III	3	-	-	20	20	60	100	3
PEC 4	BTAPE604/ BTMPE604	Elective-IV	3	-	-	20	20	60	100	3
OEC 2	BTMOE605	Open Elective-II	3	1	-	20	20	60	100	3
PCC14	BTACL606	Automobile Engineering Lab IV	-	-	6	60	-	40	100	3
PROJ-3	BTAS607	B Tech Seminar	-	-	2	60	-	40	100	1
PROJ-4	BTAP 608	Mini Project			2	60		40	100	2
PROJ-5	BTAI609 (IT – 3)	Field Training/Industrial Training (minimum of 4 weeks which can be completed partially in third semester and fourth semester or in at one time).	-	-	-	-	-	-	-	Credits to be evaluated in VII Sem.
		Total	**15**	**3**	**10**	**280**	**100**	**420**	**800**	**23**

Elective III:

Sr.No	Subject code	Subject Name
1	BTAPE603A	Vehicle Architecture and Packaging
2	BTAPE603B	Computer Simulation of IC Engine Processes
3	BTAPE603C	Automobile Body Design (Pre-requisite: Automobile Design)
4	BTAPE603D	Vehicle Aerodynamics
5	BTAPE603E	E Vehicles
6	BTAPE603F	Design of Experiments

Elective IV:

Sr.No	Subject code	Subject Name
1	BTAPE604A	Transport Management
2	BTAPE604B	Computational Fluid Dynamics
3	BTAPE604C	Ergonomics in Automotive Design
4	BTAPE604D	Tractor and Farm Equipment
5	BTAPE604E	Noise and Vibration
6	BTMPE604B	Product Life Cycle Management
7	BTMPE604C	Finite Element Method
8	BTMPE604D	Robotics

Open Elective II:

Sr.No,	Subject code	Subject Name
1	BTMOE605A	Quantitative Techniques and Project Management
2	BTMOE605B	Nanotechnology
3	BTMOE605C	Energy Conservation and Management
4	BTMOE605D	Wind Energy
5	BTMOE605E	Introduction to Probability Theory and Statistics

Course Structure for Semester VII
B.Tech in Automobile Engineering (w.e.f. 2023-24)

Semester VII										
Course Category	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**				**Credit**
			L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
PCC 15	BTAC701	Vehicle Performance and Testing	3	1	-	20	20	60	100	4
HSSMC4	BTHM702	Industrial Engineering and Management	3	1	-	20	20	60	100	4
PEC 5	BTAPE703/ BTMPE703	Elective-V	3	-	-	20	20	60	100	3
OEC 3	BTMOE704	Open Elective-III	3	-	-	20	20	60	100	3
OEC 4	BTMOE705	Open Elective-IV	3	-	-	20	20	60	100	3
PCC 16	BTACL706	Automobile Engineering Lab -V	-	-	4	60	-	40	100	3
PROJ-5	BTAI608 (IT – 3)	IT – 3 Evaluation	-	-	-	-	-	100	100	1
		Total	**15**	**2**	**04**	**160**	**100**	**440**	**700**	**21**

Elective V:

Sr.No,	**Subject code**	**Subject Name**
1	BTAPE703A	Design & Manfg. of Automotive Components
2	BTAPE703B	Virtual Reality
3	BTAPE703C	Actuation System
4	BTAPE703D	Electric and Hybrid Vehicles
5	BTAPE703E	Safety & Regulations (Automotive)
6	BTAPE703F	Motor Insurance Practices
7	BTMPE703B	Biomechanics

Open Elective III:

Sr. No.	**Subject code**	**Subject Name**
1	BTMOE704A	Sustainable Development
2	BTMOE704B	Entrepreneurship Development
3	BTMOE704C	Plant Maintenance

Open Elective IV:

Sr. No.	**Subject code**	**Subject Name**
1	BTMOE705A	Engineering Economics
2	BTMOE705B	Biology for Engineers
3	BTMOE705C	Intellectual Property Rights

Course Structure for Semester VIII
B.Tech in Automobile Engineering (w.e.f. 2023-24)

Semester VIII										
Course Category	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**				**Credit**
			L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
PROJ-6	BTAP801/ BTAI801	Project work/ Internship	-	-	24	60	-	40	100	12
		Total	**-**	**-**	**24**	**60**	**-**	**40**	**100**	**12**

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***	**160**

S. N.	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	21 +3 *	26	23	21	12	**160**
	Total	**160**	**37**		**44**		**45**		**34**		

*over and above of 160 credits

SEMESTER I
Guide to Induction Program

When new students enter an institution, they come with diverse thoughts, backgrounds and preparations. It is important to help them adjust to the new environment and inculcate in them the ethos of the institution with a sense of larger purpose. Precious little is done by most of the institutions, except for an orientation program lasting a couple of days.

We propose a 3-week long induction program for the UG students entering the institution, right at the start. Normal classes start only after the induction program is over. Its purpose is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awarness, sensitivity and understanding of the self, people around them, society at large, and nature.

The time during the Induction Program is also used to rectify some critical lacunas, for example, English background, for those students who have deficiency in it.

The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

- **Physical Activity** This would involve a daily routine of physical activity with games and sports. It would start with all students coming to the field at 6 am for light physical exercise or yoga. There would also be games in the evening or at other suitable times according to the local climate. These would help develop team work. Each student should pick one game and learn it for three weeks. There could also be gardening or other suitably designed activity where labour yields fruits from nature.
- **Creative Arts** Every student would chose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it everyday for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, flow into engineering design later.
- **Universal Human Values:** It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting staff in the hostel and department, be sensitive to others, etc. Need for character building has been underlined earlier. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and dont's, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing. The role of group discussions, however, with clarity of thought of the teachers cannot be over emphasized. It is essential for giving exposure, guiding thoughts, and realizing values. The teachers must come from all the departments rather than only one department like HSS or from outside of the Institute. Discussions would be conducted in small groups of about 20 students with a faculty mentor each. It is to open thinking towards the self. Universal Human Values discussions could even continue for rest of the semester as a normal course, and not stop with the induction program. Besides drawing the attention of the student to larger issues of life, it would build relationships between teachers and students which last for their entire 4-year stay and possibly beyond.
- **Literary** Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.
- **Proficiency Modules:** This period can be used to overcome some critical lacunas that students might have, for example, English, computer familiarity etc. These should run like crash courses, so that when normal courses start after the induction program, the student has overcome the lacunas substantially. We hope that problems arising due to lack of English skills, wherein students start lagging behind or failing in several subjects, for no fault of theirs, would, hopefully, become a thing of the past.
- **Lectures by Eminent People** This period can be utilized for lectures by eminent people, say, once a week. It would give the students exposure to people who are socially active or in public life.
- **Visits to Local Area** A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged.
- **Familiarization to Dept./Branch & Innovations :** The students should be told about different method of study compared to coaching that is needed at IITs. They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilties.

Schedule

The activities during the Induction Program would have an ***Initial Phas***e, a ***Regular Phase*** and a ***Closing Phase***. The Initial and Closing Phases would be two days each.

Initial Phase

Time	Activity
Day 0	
Whole day	Students arrive - Hostel allotment. (Preferably do preallotment)
Day 1	
9.00 AM to 3.00 PM	Academic Registration
4.30 PM to 6.00 PM	Ori Orientation
Day 2	
9.00 AM to 10.00 AM	Diagnostic test (for English etc.) Visi
10.15 AM to 12.25 PM	Visits to Respective Departments
12.30 to 2.00	Lunch time
2.00 PM to 3.00 PM	Director's Speech
3.00 PM to 4.00 PM	Interaction with Parents
4.00 PM to 5.30 PM	Mentor-Mentee groups- Introduction within group

Regular Phase

After two days is the start of the Regular Phase of induction. With this phase there would be regular program to be followed every day.

Daily Schedule

Some of the activities are on a daily basis, while some others are at specified periods within the Induction Program. We first show a typical daily timetable.

Session	Time	Activity	Remark
Day 3 Onwards			
I	9.00 AM to 11.00 AM	Creative Arts / Universal Human Values	Half the groups will do creative arts
II	11.00 AM to 1.00 PM	Universal Human Values/ Creative Arts	Complementary Alternate
Lunch Time			
IV	2.00 PM to 4.00 PM	Afternoon Session	See below
V	4.00 PM to 5.00 PM	Afternoon Session	See below

Sundays are off. Saturdays have the same schedule as above or have outing.

Afternoon Activities (Non-Daily) : The following five activities are scheduled at different times of the Induction Program, and are not held daily for everyone:

1. Familiarization to Dept./Branch & Innovations
2. Visits to Local Area
3. Lectures by Eminent People
4. Literary
5. Proficiency Modules

Closing Phase

Time	Activity
Last But one day	
9.00 AM to 12.00 PM	Discussions and finalizations of presentations within each group
2.00 PM to 5.00 PM	Presentation by each group in front of 4 other groups besides their own (about 100 students)
Last Day	
Whole day	Examinations if any

Follow Up after Closure

A question comes up as to what would be the follow up program after the formal 3-week Induction Program is over? The groups which are formed should function as mentor- mentee network. A student should feel free to approach his faculty mentor or the student guide, when facing any kind of problem, whether academic or financial or psychological 6etc. (For every 10 undergraduate first year students, there would be a senior student as a student guide, and for every 20 students, there would be a faculty mentor.) Such a group should remain for the entire 4-5 year duration of the stay of the student. Therefore, it would be good to have groups with the students as well as teachers from the same department/discipline Here we list some important suggestions which have come up and which have been experimented with.

- **Follow Up after Closure – Same Semester:** It is suggested that the groups meet with their faculty mentors once a month, within the semester after the 3-week Induction Program is over. This should be a scheduled meeting shown in the timetable. (The groups are of course free to meet together on their own more often, for the student groups to be invited to their faculty mentor's home for dinner or tea, nature walk, etc.)
- **Follow Up – Subsequent Semesters:** It is extremely important that continuity be maintained in subsequent semesters. It is suggested that at the start of the subsequent semesters (upto fourth semester), three days be set aside for three full days of activities related to follow up to Induction Program. The students be shown inspiring films, do collective art work, and group discussions be conducted. Subsequently, the groups should meet at least once a month.

Summary

Engineering institutions were set up to generate well trained manpower in engineering with a feeling of responsibility towards oneself, one's family, and society. The incoming undergraduate students are driven by their parents and society to join engineering without understanding their own interests and talents. As a result, most students fail to link up with the goals of their own institution. The graduating student must have values as a human being, and knowledge and meta-skills related to his/her profession as an engineer and as a citizen. Most students who get demotivated to study engineering or their branch, also lose interest in learning.
The Induction Program is designed to make the newly joined students feel comfortable, sensitize them towards exploring their academic interests and activities, reducing competition and making them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and building of character.

The Universal Human Values component, which acts as an anchor, develops awareness and sensitivity, feeling of equality, compassion and oneness, draw attention to society and 4
We are aware that there are advantages in mixing the students from different depts. However, in mixing, it is our experience that the continuity of the group together with the faculty mentor breaks down soon after. Therefore, the groups be from the same dept. but hostel wings have the mixed students from different depts. For example, the hostel room allotment should be in alphabetical order irrespective of dept. 7nature, and character to follow through. It also makes them reflect on their relationship with their families and extended family in the college (with hostel staff and others). It also connects students with each other and with teachers so that they can share any

difficulty they might be facing and seek help.

References:

Motivating UG Students Towards Studies, Rajeev Sangal, IITBHU Varanasi, Gautam Biswas, IIT Guwahati, Timothy Gonsalves, IIT Mandi, Pushpak Bhattacharya, IIT Patna, (Committee of IIT Directors),
31 March 2016, IIT Directors' Secretariat, IIT Delhi.

BTBS101 Engineering Mathematics – I

Teaching Scheme:	Examination Scheme:
Lecture: 3 hrs/week Tutorial: 1 hrs/week	Internal Assessment: 20 Marks Mid Term Test: 20 Marks End Semester Exam: 60 Marks

Course Contents:

Unit 1: Linear Algebra- Matrices

Inverse of a matrix by Gauss-Jordan method; Rank of a matrix; Normal form of a matrix ; Consistency of non- homogeneous and homogeneous system of linear equations ; Eigen values and eigen vectors ; Properties of eigen values and eigen vectors (without proofs); Cayley-Hamilton's theorem (without proof) and its applications. **[06 Hours]**

Unit 2: Partial Differentiation

Partial derivatives of first and higher orders; Homogeneous functions – Euler's Theorem for functions containing two and three variables (with proofs); Total derivatives; Change of variables. **[06 Hours]**

Unit 3: Applications of Partial differentiation

Jacobians - properties; Taylor's and Maclaurin's theorems (without proofs) for functions of two variables; Maxima and minima of functions of two variables; Lagrange's method of undetermined multipliers. **[06 Hours]**

Unit 4:Reduction Formulae and Tracing of Curves

Reduction formulae for $\int_0^{\frac{\pi}{2}} sin^n x\, dx$, $\int_0^{\frac{\pi}{2}} cos^n x\, dx$, $\int_0^{\frac{\pi}{2}} sin^m x\, cos^n x\, dx$; Tracing of standard curves given in Cartesian, parametric & polar forms. **[06 Hours]**

Unit 5: Multiple Integrals

Double integration in Cartesian and polar co-ordinates; Evaluation of double integrals by changing the order of integration and changing to polar form; Triple integral; Applications of multiple integrals to find area as double integral , volume as triple integral and surface area. **[08 Hours]**

Text Books

1. Higher Engineering Mathematics by B. S. Grewal, Khanna Publishers, New Delhi.
2. Higher Engineering Mathematics by H. K. Das and Er. Rajnish Verma, S. Chand & CO. Pvt. Ltd., New Delhi.
3. A course in Engineering Mathematics (Vol I) by Dr. B. B. Singh, Synergy Knowledgeware, Mumbai.
4. Higher Engineering Mathematics by B. V. Ramana, Tata McGraw-Hill Publications, New Delhi.

Reference Books

1. Advanced Engineering Mathematics by Erwin Kreyszig, John Wiley & Sons, New York.
2. A Text Book of Engineering Mathematics by Peter O' Neil, Thomson Asia Pte Ltd. , Singapore.
3. Advanced Engineering Mathematics by C. R. Wylie & L. C. Barrett, Tata Mcgraw-Hill Publishing Company Ltd., New Delhi.

General Instructions:

1. The tutorial classes in Engineering Mathematics-I are to be conducted batchwise. Each class should be divided into three batches for the purpose.

2. The internal assessment of the students for 20 marks will be done based on assignments, surprise tests, quizzes, innovative approach to problem solving and percentage attendance.
3. The minimum number of assignments should be eight covering all topics.

BTBS102 Engineering Physics

Teaching Scheme:	Examination Scheme:
Lecture: 3 hrs/week Tutorial: 1 hrs/week	Internal Assessment: 20 Marks Mid Term Test: 20 Marks End Semester Exam: 60 Marks

Objectives:

1. To provide a firm grounding in the basic physics principles and concept to resolve many Engineering and technological problems.
2. To understand and study the Physics principles behind the developments of Engineering materials.

Course Contents:

Unit I:

Oscillatio, Ultrasonics and Dielectric Materials: (06 Hrs) Free oscillation, damped oscillation, Forced oscillation and Resonance, differential wave equation, Ultrasonic waves, production of ultrasonics (Piezoelectric effect, Magnetostriction effect) and its applications.

Dielectric parameters (Dielectric constant, Electric displacement, Polarization & Polarizability), Types of polarization, temperature and frequency dependences of dielectric materials.

Unit II:

Optics, Fibre Optics and Laser: (06 Hrs)

Interference of light in thin film, wedge shaped film , Newton's rings, polarization of light, methods for production of polarized light(Reflection, Refraction& Double refraction), Huygen's theory of double refraction, Laurent's half shade Polarimeter, Principle and structure of optical fibre, acceptance angle, acceptance cone, numerical aperture.

Principle of laser, Einstein's coefficients, Types of laser – Ruby and He-Ne laser and their applications.

Unit III:

Electron Optics, Nuclear Physics and Quantum Mechanics: (06 Hrs)

Measurement of 'e/m' by Thomson's method, Determination of electronic charge by Millikan's oil drop method, Bainbridge mass spectrograph, GM counter, Heisenberg's uncertainty principle, Schrödinger's time dependent and time independent wave equations, physical significance of wave function.

Unit IV

Crystal Structure, X-rays and Electrodynamics:(06 Hrs)

Unit cell, Bravais lattice, cubic system, number of atoms per unit cell, coordination number, atomic radius, packing density, relation between lattice constant and density, lattice planes and Miller indices, Interplaner spacing for cubic system, Bragg's law, X-ray diffraction, Line and Continuous Spectrum of X-ray, Mosley's law. Introduction of Maxwell equations(no derivation), Electromagnetic wave in free space.

Unit V

Magnetic, Superconducting and Semiconducting materials: (06 Hrs)

Types of magnetic materials(Ferrimagnetic & Antiferromagnetic, Ferrites & Garnets), B-H curve, Classical free electron theory-electrical conductivity, resistivity and its temperature dependence, microscopic Ohm's law, Superconductivity, types of superconductors, Meissner effect and Applications. Band theory of solids, conductivity of semiconductors, Hall effect.

Expected Outcome:-

1. The student will be able to understand Engineering problems based on the principle of Oscillation, Ultrasonics, Optics, Laser, Fibre optics, Nuclear physics, Quantum mechanics.
2. The student will be able to understand Fundamental of Electrodynamics, Semiconductor, Dielectric, Magnetic and Superconducting materials which forms the base of many modern devices and technologies.

Text books:

1. Engineering Physics M.N. Avadhanulu and P.G. Kshirsagar. S.Chand and Company LTD.
2. Engineering Physics – Dr. L. N. Singh. Synergy Knowledgeware-Mumbai.
3. Engineering Physics - R.K. Gaur and S. L. Gupta. Dhanpat Rai Publications Pvt. Ltd.-New Delhi.
4. Fundamental of Physics - Halliday and Resnik. Willey Eastern Limited.

Reference books:

1. Introduction to Electrodynamics –David R. Griffiths.
2. Concept of Modern Physics – Arthur Beizer. Tata McGraw-Hill Publishing Company Limited.
3. Optics – Ajoy Ghatak.MacGraw Hill Education (India) Pvt. Ltd.
4. Science of Engineering Materials- C.M. Srivastava and C. Srinivasan. New Age International Pvt.Ltd.
5. Solid State Physics – A.J. Dekker. McMillan India –Limited.
6. The Feynman Lectures on Physics Vol I,II,III.
7. Introduction to solid state physics – Charles Kittel. John Willey and Sons

BTES103 Engineering Graphics

Teaching Scheme:	Examination Scheme:
Lecture: 2 hrs/week	Internal Assessment: 20 Marks Mid Term Test: 20 Marks End Semester Exam: 60 Marks (Duration 04 hrs)

Course Contents:

Unit 1: Drawing standards and geometrical construction: 4hrs

Drawing standard SP: 46, Type of lines, lettering, dimensioning, scaling conventions. Geometrical construction: Dividing a given straight line into any number of equal parts, bisecting a given angle, drawing a regular polygon given one side, special methods of constructing a pentagon and a hexagon.

Unit 2: Orthographic Projections and Projections of Points: 4hrs

Introduction to orthographic projection, drawing of orthographic views of objects from their isometric views. Projection of points lying in four quadrants.

Unit 3: Projections of Straight Lines and Planes and their Traces : 4hrs

Projections of lines parallel and perpendicular to one or both planes, projections of lines inclined to one or both planes. Traces of lines. Projections of planes parallel and perpendicular to one or both planes, projection of planes inclined to one or both planes.

Unit 4: Projections of Solids 4hrs

Types of solids, projections of solids with axis perpendicular and parallel to HP and VP, solids with axis inclined to one or both the planes. Projections of spheres touching each other.

Unit 5: Sectioning of Solids, Isometric Projections 4hrs

Sectioning of solids: Section planes perpendicular to one plane and parallel or inclined to other plane. Isometric projections: Isometric scale, drawing of isometric projections from given orthographic views.

Reference/Text Books:

1. N. D. Bhatt, *Engineering Drawing*, Charotar Publishing House, 46th Edition, 2003.
2. K. V. Nataraajan, *A text book of Engineering Graphic*, Dhanalakshmi Publishers, Chennai, 2006.
3. K. Venugopal and V. Prabhu Raja, *Engineering Graphics*, New Age International (P) Ltd, 2008.
4. Dhananjay A. Jolhe, *Engineering Drawing with an Introduction to Autocad*, McGraw Hill Education, 2017.

BTHM104 Communication Skills

Teaching Scheme:	Examination Scheme:
Lecture: 2 hrs/week	Internal Assessment: 20 Marks Mid Term Test: 20 Marks End Semester Exam: 60 Marks

Course Contents:

Unit 1: Communication and Communication Processes (04 hrs)
Introduction to Communication, Forms and functions of Communication, Barriers to Communication and overcoming them, Verbal and Non-verbal Communication
Reading: Introduction to Reading, Barriers to Reading, Types of Reading: Skimming, Scanning, Fast Reading, Strategies for Reading, Comprehension.
Listening : Importance of Listening, Types of Listening, Barriers to Listening.

Unit 2: Verbal & Non-verbal Communication (04 hrs)
Use of Language in Spoken Communication, Principles and Practice of Group Discussion, Public Speaking (Addressing Small Groups and Making Presentation), Interview Techniques, Appropriate Use of Non-verbal Communication, Presentation Skills, Extempore, Elocution.

Unit 3: Study of Sounds in English (02 hrs)
Introduction to phonetics, Study of Speech Organs, Study of Phonemic Script, Articulation of Different Sounds in English.

Unit 4: English Grammar (05 hrs)
Grammar: Forms of Tenses, Articles, Prepositions, Use of Auxiliaries and Modal Auxiliaries, Synonyms and Antonyms, Common Errors.

Unit 5: Writing Skills, Reading Skills & Listening Skills (04 hrs)
Features of Good Language, Difference between Technical Style and Literary Style, Writing Emails, Formal and Informal English, Technical Reports: Report Writing: Format, Structure and Types
Letter Writing: Types, Parts, Layouts, Letters and Applications, Use of Different Expressions and Style, Writing Job Application Letter and Resume.

Text book:

1. Mohd. Ashraf Rizvi, *Communication Skills for Engineers*, Tata McGraw Hill

Reference Books:

1. Sanjay Kumar, Pushp Lata, *Communication Skills*, Oxford University Press, 2016
2. Meenakshi Raman, Sangeeta Sharma, *Communication Skills*, Oxford University Press, 2017
3. Teri Kwal Gamble, Michael Gamble, *Communication Works*, Tata McGraw Hill Education, 2010
4. Anderson, Kenneth. Joan Maclean and Tossny Lynch. Study Speaking: A Course in Spoken English for Academic Purposes. Cambridge: CUP, 2004.
5. Aswalthapa, K. *Organisational Behaviour*, Himalayan Publication, Mumbai (1991).
6. Atreya N and Guha, *Effective Credit Management*, MMC School of Management, Mumbai (1994).
7. Balan,K.R. and Rayudu C.S., *Effective Communication*, Beacon New Delhi (1996).
8. Bellare, Nirmala. *Reading Strategies*. Vols. 1 and 2. New Delhi. Oxford University Press, 1998.
9. Bhasker, W. W. S & Prabhu, N. S.: *English through Reading*, Vols. 1 and 2. Macmillan, 1975.
10. Black, Sam. *Practical Public Relations*, E.L.B.S. London (1972).
11. Blass, Laurie, Kathy Block and Hannah Friesan. *Creating Meaning*. Oxford: OUP, 2007.

12. Bovee Courtland,L and Thrill, John V. *Business Communication*, Today McGraw Hill, New York, Taxman Publication (1989).

BTES105 Energy and Environment Engineering

Teaching Scheme:	Examination Scheme:
Lecture: 2 hrs/week	Internal Assessment: 20 Marks Mid Term Test: 20 Marks End Semester Exam: 60 Marks

Course Contents:

Unit 1

Conventional Power Generation: Steam power station, Nuclear power plant – Gas turbine power plant- Hydro power station: Schematic arrangement, advantages and disadvantages, Thermo electric and thermionic generators, Environmental aspects for selecting the sites and locations of power plants.[**4 hrs]**

Unit 2

Renewable Power Generation: Solar, Wind, Biogas and Biomass, Ocean Thermal energy conversion (OTEC), Tidal, Fuel cell, Magneto Hydro Dynamics (MHD): Schematic arrangement, advantages and disadvantages.[**4 hrs]**

Unit 3

Energy conservation: Scope for energy conservation and its benefits Energy conservation Principle – Maximum energy efficiency, Maximum cost effectiveness, Methods and techniques of energy conservation in ventilation and air conditioners, compressors, pumps, fans and blowers, Energy conservation in electric furnaces, ovens and boilers., lighting techniques.[**4 hrs]**

Unit 4

Air Pollution: Environment and Human health - Air pollution: sources- effects- control measures - Particulate emission, air quality standards, and measurement of air pollution.[**4 hrs]**

Unit 5

Water Pollution: Water pollution- effects- control measures- Noise pollution –effects and control measures, Disposal of solid wastes, Bio-medical wastes-Thermal pollution – Soil pollution -Nuclear hazard.[**4 hrs]**

Reference/Text Books:

1. A Chakrabarti, M. L Soni, P. V. Gupta, U. S. Bhatnagar, A Text book of Power System Engineering, Dhanpat Rai Publication.
2. Rai. G. D., Non Conventional Energy Sources, Khanna Publishers, Delhi, 2006.
3. Rao S., Parulekar B.B., Energy Technology-Non conventional, Renewable And Conventional, Khanna Publishers, Delhi, 2005.
4. Glynn Henry J., Gary W. Heinke, Environmental Science and Engineering, Pearson Education, Inc, 2004.
5. J. M. Fowler, Energy and the Environment, McGraw-Hill, 2 nd Edition, 1984.
6. Gilbert M. Masters, Introduction to Environmental Engineering and Science, 2nd Edition, Prentice Hall, 2003.

BTES106 Basic Civil and Mechanical Engineering

Teaching Scheme:	Examination Scheme:
Lecture: 2 hrs/week	Internal Assessment: 50 Marks (Audit)

Course Contents:

Part I Basic Civil Engineering

Unit 1: Introduction to civil engineering (4hrs)

Various Branches, role of civil engineer in various construction activities, basic engineering properties and uses of materials: earth, bricks, timber, stones, sand, aggregates, cement, mortar, concrete, steel, bitumen, glass, FRP, composite materials.

Unit 2: Building Components & Building Planning (4hrs)

Foundation and superstructure, functions of foundation, types of shallow and deep foundations, suitability in different situation, plinth, walls, lintels, beams, columns, slabs, roofs, staircases, floors, doors, windows, sills, Study of Building plans, ventilation, basics of plumbing and sanitation

Unit 3: Surveying (4hrs)

Principles of survey, elements of distance and angular measurements, plotting of area, base line and offsets, introduction to Plane table surveying, introduction to levelling, concept of bench marks, reduced level, contours

Part II Basic Mechanical Engineering

Unit 4: Introduction to Mechanical Engineering, Introduction to Laws of Thermodynamics with simple examples pertaining to respective branches, IC Engines: Classification, Applications, Basic terminology, 2 and 4 stroke IC engine working principle, Power Plant: Types of Power plant; Gas power plant, Thermal power plant, Nuclear power plant, Automobiles: Basic definitions and objective **(4 hrs)**

Unit 5: Design Basics, Machine and Mechanisms, Factor of safety, Engineering Materials: types and applications, basics of Fasteners Machining and Machinability, Introduction to Lathe machine, Drilling machine, Milling machine, basics of machining processes such as turning, drilling and milling, Introduction to casting **(4 hrs)**

Text Books

1. Anurag Kandya, “Elements of Civil Engineering”, Charotar Publishing, Anand
2. M. G. Shah, C. M. Kale, and S. Y. Patki, “Building Drawing”, Tata McGraw Hill
3. Sushil Kumar, “Building Construction”, Standard Publishers Distributors
4. M. S. Palani Gamy, “Basic Civil Engineering”, Tata Mc-Graw Hill Publication
5. Kanetkar T. P. and Kulkarni S. V., “Surveying and Levelling”, Vols. I, II and III, Vidyarthi Gruh Prakashan, Pune
6. B. C. Punmia, “Surveying”, Vol.- I, Vol.-II, Vol.-III, Laxmi Publications
7. G. K. Hiraskar, “Basic Civil Engineering”, Dhanpat Rai Publications
8. Gopi Satheesh, “Basic Civil Engineering”, Pearson Education
9. P. K. Nag “Engineering Thermodynamics”, Tata McGraw Hill, New Delhi 3rd ed. 2005
10. A. Ghosh, A K Malik, “Theory of Mechanisms and Machines”, Affiliated East West Press Pvt. Ltd. New Delhi.
11. Serope Kalpakaji and Steven R Schimd “ Amanufacturing Engineering and Techology” Addision Wsley Laongman India 6th Edition 2009
12. V. B. Bhandari, “ Deisgn of Machine Elements”, Tata McGraw Hill Publications, New Delhi.

BTBS107L Engineering Physics Lab

Practical Scheme:	Examination Scheme:
Practical: 2 hrs/batch	Internal Assessment: 60 Marks External Exam: 40 Marks

Course Contents:

At least 10 experiments should be performed from the following list.

1. Newton's rings - Determination of radius of curvature of Plano convex lens / wavelength of light
2. Wedge Shaped film - Determination of thickness of thin wire
3. Half shade Polarimeter - Determination of specific rotation of optically active material
4. Laser - Determination of wavelength of He-Ne laser light
5. Magnetron Tube - Determination of 'e/m' of electron
6. G.M. Counter - Determination of operating voltage of G.M. tube
7. Crystal Plane – Study of planes with the help of models related Miller Indices
8. Hall Effect - Determination of Hall Coefficient
9. Four Probe Method - Determination of resistivity of semiconductor
10. Measurement of Band gap energy of Semiconductors
11. Study of I-V characteristics of P-N junction diode
12. Experiment on fibre optics
13. Ultrasonics Interferometer
14. B-H Curve Experiment
15. Susceptiblity measurement experiment

BTES108L Engineering Graphics Lab

Practical Scheme:	**Examination Scheme:**
Practical: 3 hrs/batch	Internal Assessment: 60 Marks External Exam: 40 Marks

Course Contents:

List of Practical:

1. Lines, lettering and dimensioning.
2. Geometrical Constructions. (AutoCAD)
3. Orthographic projections. (AutoCAD)
4. Projections of points. (AutoCAD)
5. Projections of straight lines. (AutoCAD)
6. Projections of planes.
7. Projections of solids.
8. Section of solids.
9. Isometric Projections. (AutoCAD)

BTHM109L Communication Skills Lab

Practical Scheme:	Examination Scheme:
Practical: 2 hrs/batch	Internal Assessment: 60 Marks External Exam: 40 Marks

Course Contents:

List of Practicals (Any 10 PR sessions can be conducted)

1. How to introduce oneself ? (02 hrs)
2. Introduction to Phonemic symbols (02 hrs)
3. Articulation of sounds in English with proper manner (02 hrs)
4. Practice and exercises on articulation of sounds (02 hrs)
5. Read Pronunciations/transcriptions from the dictionary (02 hrs)
6. Practice and exercises on pronunciations of words (02 hrs)
7. Introduction to stress and intonation (02 hrs)
8. Rapid reading sessions (02 hrs)
9. Know your friend (02 hrs)
10. How to introduce yourself (02 hrs)
11. Extempore (02 hrs)
12. Group discussion (02 hrs)
13. Participating in a debate (02 hrs)
14. Presentation techniques (02 hrs)
15. Interview techniques (02 hrs)

SEMESTER II
BTBS201 Engineering Mathematics II

Teaching Scheme:	Examination Scheme:
Lecture: 3 hrs/week Tutorial: 1 hrs/week	Internal Assessment: 20 Marks Mid Term Test: 20 Marks End Semester Exam: 60 Marks

Course Content:

Unit 1: Complex Numbers
Definition and geometrical representation ; De-Moivre's theorem(without proof) ; Roots of complex numbers by using De-Moivre's theorem ; Circular functions of complex variable – definition ; Hyperbolic functions ; Relations between circular and hyperbolic functions ; Real and imaginary parts of circular and hyperbolic functions ; Logarithm of Complex quantities. **[09 Hours]**

Unit 2: Ordinary Differential Equations of First Order and First Degree and Their Applications
Linear equations; Reducible to linear equations (Bernoulli's equation); Exact differential equations; Equations reducible to exact equations ; Applications to orthogonal trajectories , mechanical systems and electrical systems. **[09 Hours]**

Unit 3: Higher Order Linear Differential Equations with Constant Coefficients
Introductory remarks - complementary function, particular integral ; Rules for finding complementary functions and particular integrals ; Method of variation of parameters ; Cauchy's homogeneous and Legendre's linear equations. **[09 Hours]**

Unit 4: Fourier Series
Introductory remarks- Euler's formulae ; Conditions for Fourier series expansion - Dirichlet's conditions ; Functions having points of discontinuity ; Change of interval ; Odd and even functions - expansions of odd and even periodic functions ; Half -range series. **[09 Hours]**

Unit 5: Vector Calculus
Scalar and vector fields: Gradient , divergence and curl ; Solenoidal and irrotational vector fields; Vector identities (statement without proofs) ; Green's lemma , Gauss' divergence theorem and Stokes' theorem (without proofs) . **[09 Hours]**

Text Books

1. Higher Engineering Mathematics by B. S. Grewal, Khanna Publishers, New Delhi.
2. Higher Engineering Mathematics by H. K. Das and Er. Rajnish Verma, S. Chand & CO. Pvt. Ltd., New Delhi.
3. A course in Engineering Mathematics (Vol II) by Dr. B. B. Singh, Synergy Knowledgeware, Mumbai.
4. Higher Engineering Mathematics by B. V. Ramana, Tata McGraw-Hill Publications, New Delhi.

Reference Books

1. Advanced Engineering Mathematics by Erwin Kreyszig, John Wiley & Sons, New York.
2. A Text Book of Engineering Mathematics by Peter O' Neil, Thomson Asia Pte Ltd. , Singapore.
3. Advanced Engineering Mathematics by C. R. Wylie & L. C. Barrett, Tata Mcgraw-Hill Publishing Company Ltd., New Delhi.

General Instructions:

1. The tutorial classes in Engineering Mathematics-II are to be conducted batchwise. Each class should be divided into three batches for the purpose.
2. The internal assessment of the students for 20 marks will be done based on assignments, surprise tests, quizzes, innovative approach to problem solving and percentage attendance.
3. The minimum number of assignments should be eight covering all topics.

BTBS202 Engineering Chemistry

Teaching Scheme:	Examination Scheme:
Lecture: 3 hrs/week Tutorial: 1 hrs/week	Internal Assessment: 20 Marks Mid Term Test: 20 Marks End Semester Exam: 60 Marks

Course Content:

Unit 1: Water Treatment **(7L)**

Introduction , Hard and Soft water, Disadvantages of hard water –In Domestic use, In Industrial use, Softening of water – Zeolite process, Ion exchange process, Hot Lime –Soda process, water characteristics- Hardness and its determination by EDTA method, Dissolved oxygen (DO) and its determination by Winkler's method.

Unit 2: Phase Rule **(6L)**

Phase Rule, statement, Explanation of the terms – Phase, Component, Degrees of freedom. One component system–Water and Sulphur, Reduced Phase rule equation, Two component alloy system- Phase diagram of Silver- Lead alloy system.

Unit 3: Corrosion and its Control **(7L)**

Introduction, Fundamental reason of corrosion, Electrochemical Corrosion, Mechanism of Electrochemical corrosion: a) Hydrogen Evolution Mechanism b) Absorption of Oxygen Mechanism, Direct Chemical Corrosion(Dry corrosion), Factors affecting the rate of corrosion, Methods to minimise the rate of corrosion: Proper designing , Cathodic and Anodic protection method.

Unit 4: Fuels and Lubricants **(7L)**

Fuels: Introduction, Classification of fuel, Calorific value of a fuel, Characteristics of a good fuel, solid fuel- Coal and Various types of Coal, Analysis of coal- Proximate and Ultimate analysis, Liquid fuel- Refining of Petroleum.

Lubricants: Introduction, Classification of lubricants - Solid, Semi–solid and Liquid Lubricants, Properties of lubricants: Physical properties – Viscosity, Viscosity index, Surface tension, Flash point and Fire point. Chemical properties - Acidity, Saponification.

Unit 5: Electrochemistry **(7L)**

Introduction –**Basic Concepts:** Definition and units of Ohm's Law, Specific Resistance, Specific Conductance, Equivalent Conductance, Molecular Conductance. Method of conductance measurement by Wheatstone bridge method, Cell constant, Conductometric titrations, Glass electrode, Nernst equation and its application for the calculation of half-cell potential, Fuel cell(H_2-O_2 fuel cell), Advantages of fuel cell, Ostwald's theory of acid- base indicator.

Text books:

1. Jain P.C & Jain Monica, Engineering Chemistry, Dhanpat Rai & Sons, Delhi, 1992.
2. Bhal & Tuli, Text book of Physical Chemistry, S. Chand & Company, New Delhi.
3. Shikha Agarwal, Engineering Chemistry- Fundamentals and applications, Cambridge Publishers - 2015.

Reference books:

1. Barrow G.M., Physical Chemistry, McGraw-Hill Publication, New Delhi.
2. O. G. Palanna , Engineering Chemistry, Tata McGraw-Hill Publication, New Delhi.
3. WILEY, Engineering Chemistry, Wiley India, New Delhi 2014.
4. S.S.Dara, Engineering Chemistry,McGraw Hill Publication, New Delhi.

BTES203 Engineering Mechanics

Teaching Scheme:	Examination Scheme:
Lecture: 2 hrs/week Tutorial: 1 hrs/week	Internal Assessment: 20 Marks Mid Term Test: 20 Marks End Semester Exam: 60 Marks

Course Content:

Unit 1:Basic Concepts (7 Lectures)
Objectives of Engineering Analysis and Design, Idealization of Engineering Problems, Simplification of real 3D problems to 2-D and 1-D domain,Basis of Assumptions, types of supports, types of load, free body diagram, Laws of Motion, Fundamental principles, Resolution and composition of a forces, Resultant, couple, moment, Varignon's theorem, force systems, Centroid of composite shapes, moment of inertia of planer sectionsand radius of gyration

Unit 2:Equilibrium (7 Lectures)
Static equilibrium, analytical and graphical conditions of equilibrium, Lami's theorem, equilibrium of coplanar concurrent forces, coplanar non concurrent forces, parallel forces,beams reactionsSimple trusses (plane and space), method of joints for plane trusses, method of sections for plane trusses **Friction:**Coulomb law, friction angles, wedge friction, sliding friction and rolling resistance

Module3:Kinematics (7 Lectures)
Types of motions, kinematics of particles, rectilinear motion, constant and variable acceleration, relative motion, motion under gravity, study of motion diagrams, angular motion, tangential and radial acceleration, projectile motion, kinematics of rigid bodies, concept of instantaneous center of rotation, concept of relative velocity.

Module4:Kinetics (6 Lectures)
Mass moment of inertia, kinetics of particle, D'Alembert's principle:applications in linear motion, kinetics of rigid bodies, applications in translation, applications in fixed axis rotation

Module5: Work, Power, Energy (6 Lectures)
Principle of virtual work, virtual displacements for particle and rigid bodies, work done by a force, spring, potential energy, kinetic energy of linear motion and rotation, work energy equation, conservation of energy, power, impulse momentum principle, collision of elastic bodies.

Text Books

1. S. Timoshenko, D. H. Young, "Engineering Mechanics", McGraw Hill, 1995.
2. Tayal A. K., "Engineering Mechanics", Umesh Publications, 2010.
3. Bhavikatti S. S., Rajashekarappa K. G., "Engineering Mechanics", New Age International Publications, 2nd Edition.
4. Beer, Johnston, "Vector Mechanics for Engineers", Vol. 1: Statics and Vol. 2: Dynamics, McGraw Hill Company Publication, 7th edition, 1995.
5. Irving H. Shames, "Engineering Mechanics - Statics and Dynamics", Pearson Educations, Fourth edition, 2003.
6. McLean, Nelson, "Engineering Mechanics", Schaum's outline series, McGraw Hill Book Company, N. Delhi, Publication.
7. Singer F. L., "Engineering Mechanics - Statics & Dynamics", Harper and Row Pub. York.
8. Khurmi R. S., "Engineering Mechanics", S. Chand Publications, N. Delhi

BTES204 Computer Programming

Teaching Scheme:	Examination Scheme:
Lecture: 3hrs/week	Internal Assessment: 20 Marks Mid Term Test: 20 Marks End Semester Exam: 60 Marks

Course Content:

Unit 1

Process of programming: Editing, Compiling, Error Checking, executing, testing and debugging of programs. IDE commands. Eclipse for C Program development, Flowcharts, Algorithms. **(4 Lectures)**

Unit 2

Types, Operators and Expressions: Variable names, Data types, sizes, constants, declarations, arithmetic operators, relational and logical operators, type conversions, increment and decrement operators, bitwise operators, assignment operators and expressions, conditional expressions precedence and order of evaluation. **(4 Lectures)**

Unit 3

Control Flow: Statements and Blocks. If-else, else-if switch Loops while and for, do-while break and continue goto and Labels. Functions and Program Structure: Basic of functions, functions returning nonintegers external variables scope rules. **4 Lectures)**

Unit 4

Arrays in C: Initializing arrays, Initializing character arrays ,multidimensional arrays. **(4 Lectures)**

Unit 5

Structures C: Basics of structures, structures and functions arrays of structures. **(4 Lectures)**

Pointer in C. Pointers to integers, characters, floats, arrays, structures.

Special Note: Topic of Pointers in C is only for lab exercises and not for end semester examinations.

Reference/Text Books:

1. Brain W. Kernighan & Dennis Ritchie, The C Programming Language, Prentice Hall, 2 nd Edition, 1988.
2. R. S. Bichkar, Programming with C, Orient Blackswan, 1 st Edition, 2012.
3. Herbert Schildit, C the Complete Reference, McGraw-Hill Publication, 2000.
4. Balguruswamy, Programming in C, PHI.
5. Yashwant Kanitkar, Let Us C, PHI

BTES205 Basic Electrical and Electronics Engineering

Teaching Scheme:	Examination Scheme:
Lecture: 2 hrs/week	Internal Assessment: 50 Marks (Audit)

Course Content:

Unit 1 **(4 Lectures)**

Elementary Electrical Concepts:

Fundamental of Electrical system Potential difference, Ohm's law, Effect of temperature on resister, resistance temperature coefficient, Electrical wiring system: Study of different wire gauges and their applications in domestic and industry. Energy Resources and Utilization: Conventional and nonconventional energy resources; Introduction to electrical energy generation from different resources, transmission, distribution and utilization, Advantages & Disadvantages of AC & DC transmission. Concept of Supply Demand, Power Factor, Need of unity factor.

Unit 2 **(4 Lectures)**

Measurement of Electrical Quantities:

Measurement of Voltage, Current, and Power; Measurement of 3 phase power; Study of Energy meters. Study of Electrical Storage devices: Batteries such as Nickel-cadmium (NiCd), Lithium- ion (Li-ion), Lithium Polymer (Li-pol.) batteries. Study of circuit breakers & Actuators (MCB & MPCB, Power Contactors & Aux contactors, Electro-Mechanical & Solid state Relays)

Unit 3 **(4 Lectures)**

Diodes and Circuits:

The P-N Junction Diode, V-I characteristics, Diode as Rectifier, specifications of Rectifier Diodes, Half Wave, Full wave, Bridge rectifiers, Equations for I_{DC} V_{DC} V_{RMS}, I_{RMS}, Efficiency and Ripple Factor for each configuration. Filters: Capacitor Filter, Choke Input Filter, Capacitor Input Filter(Π Filter), Zener Diode, Characteristics, Specifications, Zener Voltage Regulator, Types of Diodes: LED, Photodiode

Unit 4 **(4 Lectures)**

Semiconductor Devices and Applications:

Transistors: Introduction, Classification, CE, CB, and CC configurations, α, β, concept of gain and bandwidth. Operation of BJT in cut-off, saturation and active regions (DC analysis). BJT as an amplifier, biasing techniques of BJT, BJT as a switch.

Introduction to Digital Electronics: Number System, Basic logic Gates, Universal Gates, Boolean Postulates, De-Morgan Theorems

Reference/Text Books:

1. V. N. Mittal and Arvind Mittal, Basic Electrical Engineering, McGraw-Hill Publication.
2. Brijesh Iyer and S. L. Nalbalwar, A Text book of Basic Electronics, Synergy Knowledgeware Mumbai, 2017. ISBN:978-93-8335-246-3
3. Vincent DelToro, Electrical engineering Fundamentals, PHI Publication, 2nd Edition, 2011.
4. Boylstad, Electronics Devices and Circuits Theory, Pearson Education.
5. Edward Hughes, Electrical Technology, Pearson Education.
6. D. P. Kothari and Nagrath, Theory and Problems in Electrical Engineering, PHI Publication, 2011.
7. B. L. Theraja, Basic Electronics, S. Chand Limited, 2007.
8. Millman Halkias, Integrated Electronics-Analog and Digital Circuits and Systems, McGraw-Hill Publication, 2000.
9. Donald Neaman, Electronic Circuit Analysis and Design, McGraw-Hill Publication, 3rd Edition.
10. Donald Neaman, Electronic Circuit Analysis and Design, McGraw-Hill Publication, 3rd Edition.
11. Printed Circuit Boards Design & Technology, Walter C. Bosshart, McGraw-Hill Publication.

Note: Students are advised to use internet resources whenever required

BTES206L Workshop Practice

Teaching Scheme:	Examination Scheme:
Practical: 4 hrs/batch	Internal Assessment: 60 Marks External Exam: 40 Marks

Instruction to Students:
Each student is required to maintain a „workshop diary" consisting of drawing / sketches of the jobs and a brief description of tools, equipment, and procedure used for doing the job.

List of Practical:

1. Wood sizing exercises in planning, marking, sawing, chiseling and grooving to make half lap joint and cross lap joint.
2. A job involving cutting, filing to saw cut, filing all sides and faces, corner rounding, drilling and tapping on M. S. plates.
3. A job on use of plumbing tools and preparation of plumbing line involving fixing of water tap and use of elbow, tee, union and coupling, etc.
4. Making a small parts using GI sheet involving development, marking, cutting, bending, brazing and soldering operations- i)Tray ii) Funnel and similar articles.
5. Exercise in Arc welding (MMAW) to make a square butt joint.
6. Exercise in Resistance (Spot) welding to make a lap joint.
7. A job using power operated tools related to sheet metal work, Welding, Fitting, Plumbing, Carpentry and pattern making.
8. A job on turning of a Mild Steel cylindrical job using center lathe.

Contents:

a) **Carpentry:** Technical Terms related to wood working, Types of wood, Joining materials, Types of joints - Mortise and Tenon, Dovetail, Half Lap, etc., Methods of preparation and applications, Wood working lathe, safety precautions.
b) **Welding:** Arc welding - welding joints, edge preparation, welding tools and equipment, Gas welding - types of flames, tools and equipment, Resistance welding - Spot welding, joint preparation, tools and equipment, safety precautions.
c) **Fitting and Plumbing:** Fitting operation like chipping, filing, right angle, marking, drilling, tapping etc., Fitting hand tools like vices, cold chisel, etc. Drilling machine and its operation, Different types of pipes, joints, taps, fixtures and accessories used in plumbing, safety precautions.
d) **Sheet Metal Work:** Simple development and cutting, bending, Beading, Flanging, Lancing and shearing of sheet metal, Sheet metal machines - Bending Machine, Guillotine shear, Sheet metal joints, Fluxes and their use.
e) **Machine shop**: Lathe machine, types of lathes, major parts, cutting tool, turning operations, safety precautions

Reference/Text Books:

1. K. C. John, Mechanical Workshop Practice, Prentice Hall Publication, New Delhi, 2010.
2. Hazra and Chaudhary, Workshop Technology-I, Media promoters & Publisher private limited.

BTBS207L Engineering Chemistry Lab

Practical Scheme:	Examination Scheme:
Practical: 2 hrs/batch	Internal Assessment: 60 Marks External Exam: 40 Marks

List of Experiments: (Perform any 8 - 10 Experiments)

1. Determination of Hardness of water sample by EDTA method.
2. Determination of Chloride content in water sample by precipitation titration method.
3. Determination of Dissolved Oxygen in water by Iodometric method.
4. Determination of Percent purity of Bleaching Powder.
5. pH – metric Titration (Acid Base titration)
6. Conductometric Titration (Acid Base titration)
7. Surface tension
8. Viscosity
9. To determine Acidity of water sample.
10. To determine Calorific value of a fuel.
11. Determination of Acid value of an oil sample.
12. Determination of Saponification value of an oil sample.
13. Experiment on water treatment by using Ion exchange resins.
14. To find out P-T curve diagram of steam.
15. To determine Alkalinity water sample.
16. Determination of rate of corrosion of metal.

Reference Books:

1. Systematic experiments in Chemistry, A. Sethi, New Age International Publication, New Delhi.
2. Practical Inorganic Chemistry, A. I. Vogel, ELBS Pub.
3. Practical in Engineering Chemistry, S. S. Dara.

BTES208L Engineering Mechanics Laboratory

Practical Scheme:	Examination Scheme:
Practical: 2 hrs/batch	Internal Assessment: 60 Marks External Exam: 40 Marks

Students are expected to satisfactorily complete any ten experiments listed below.

List of Practical's/Experiments/Assignments

1. Polygon law of coplanar forces.
2. Centroid of irregular shaped bodies.
3. Bell crank lever.
4. Support reaction for beam.
5. Problems on beam reaction by graphics statics method.
6. Simple / compound pendulum.
7. Inclined plane (to determine coefficient of friction).
8. Collision of elastic bodies (Law of conservation of momentum).
9. Moment of Inertia of fly wheel.
10. Verification of law of Machine using Screw jack
11. Verification of law of Machine using Worm and Worm Wheel
12. Verification of law of Machine using Single and Double Gear Crab.
13. Assignment based on graphics statics solutions
14. Application of Spreadsheet Program for conceptslike law of moments, beam reactions, problems in kinematics, etc.
15. Any other innovative experiment relevant to Engineering Mechanics.

Semester III
Engineering Mathematics-III

BTBS301	Engineering Mathematics-III	BSC 7	3L-1T-0P	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1hr/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	
CO2	
CO3	
CO4	
CO5	
CO6	
CO7	
CO8	

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Laplace Transform

Definition – conditions for existence ; Transforms of elementary functions ; Properties of Laplace transforms - Linearity property, first shifting property, second shifting property, transforms of functions multiplied by t^n, scale change property, transforms of functions divided by t, transforms of integral of functions, transforms of derivatives ; Evaluation of integrals by using Laplace transform ; Transforms of some special functions- periodic function, Heaviside-unit step function, Dirac delta function.

[09 Hours]

Unit 2: Inverse Laplace Transform

Introductory remarks ; Inverse transforms of some elementary functions ; General methods of finding inverse transforms ; Partial fraction method and Convolution Theorem for finding inverse Laplace transforms ; Applications to find the solutions of linear differential equations and simultaneous linear differential equations with constant coefficients.

[09 Hours]

Unit 3: Fourier Transform

Definitions – integral transforms ; Fourier integral theorem (without proof) ; Fourier sine and cosine integrals ; Complex form of Fourier integrals ; Fourier sine and cosine transforms ; Properties of Fourier transforms ; Parseval's identity for Fourier Transforms.

[09 Hours]

Unit 4: Partial Differential Equations and Their Applications

Formation of Partial differential equations by eliminating arbitrary constants and functions; Equations solvable by direct integration; Linear equations of first order (Lagrange's linear equations); Method of separation of variables – applications to find solutions of one dimensional heat flow equation $\left(\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2}\right)$, and one dimensional wave equation (i.e.$\frac{\partial^2 y}{\partial t^2} = c^2 \frac{\partial^2 y}{\partial x^2}$).

[09 Hours]

Unit 5: Functions of Complex Variables

Analytic functions; Cauchy- Riemann equations in Cartesian and polar forms; Harmonic functions in Cartesian form; Cauchy's integral theorem; Cauchy's integral formula; Residues; Cauchy's residue theorem (All theorems without proofs). **[09 Hours]**

Text Books

1. Higher Engineering Mathematics by B. S. Grewal, Khanna Publishers, New Delhi.
2. Higher Engineering Mathematics by H. K. Das and Er. Rajnish Verma, S. Chand & CO. Pvt. Ltd., New Delhi.
3. A course in Engineering Mathematics (Vol III) by Dr. B. B. Singh, Synergy Knowledgeware, Mumbai.
4. Higher Engineering Mathematics by B. V. Ramana, Tata McGraw-Hill Publications, New Delhi.

Reference Books

1. Advanced Engineering Mathematics by Erwin Kreyszig, John Wiley & Sons, New York.
2. A Text Book of Engineering Mathematics by Peter O' Neil, Thomson Asia Pte Ltd. , Singapore.
3. Advanced Engineering Mathematics by C. R. Wylie & L. C. Barrett, Tata Mcgraw-Hill Publishing Company Ltd., New Delhi.
4. Integral Transforms and their Engineering Applications by Dr. B. B. Singh, Synergy Knowledgeware, Mumbai.
5. Integral Transforms by I. N. Sneddon, Tata McGraw-Hill , New York.

General Instructions:

1. The tutorial classes in Engineering Mathematics-III are to be conducted batchwise. Each class should be divided into three batches for the purpose.

2. The internal assessment of the students for 20 marks will be done based on assignments, surprise tests, quizzes, innovative approach to problem solving and percentage attendance.
3. The minimum number of assignments should be eight covering all topics.

Fluid Mechanics

BTMC302	Fluid Mechanics	PCC 1	3L-1T-0P	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1hr/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 fluid, define and calculate various properties of fluid
CO2	Calculate hydrostatic forces on the plane and curved surfaces and explain stability of floating bodies
CO3	Explain various types of flow. Calculate acceleration of fluid particles
CO4	Apply Bernoulli's equation and Navier-Stokes equation to simple problems in fluid mechanics
CO5	Explain laminar and turbulent flows on flat plates and through pipes
CO6	Explain and use dimensional analysis to simple problems in fluid mechanics
CO7	Understand boundary layer, drag and lift
CO8	Evaluation of performance of compressors/turbines/pumps.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Basics [06 Hours]

Definition of fluid, fluid properties such as viscosity, vapour pressure, compressibility, surface tension, capillarity, Mach number etc., pressure at a point in the static mass of fluid, variation of pressure, Pascal's law, pressure measurement by simple and differential manometers using manometric expression.

Unit 2: Fluid Statics [06 Hours]

Hydrostatic forces on the plane and curved surfaces, centre of pressure, Buoyancy, centre of buoyancy, stability of floating bodies, metacentre and metacentric height its application in shipping.

Unit 3: Fluid Kinematics [08 Hours]
Velocity of fluid particle, types of fluid flow, description of flow, continuity equation, Coordinate freeform, acceleration of fluid particle, rotational and irrotational flow, Laplace's equation in velocity potential and Poisson's equation in stream function, flownet.

Unit 4: Fluid Dynamics [10 Hours]
a) Introduction to boundary layer theory and its analysis.
b) Momentum equation, development of Euler's equation, Introduction to Navier-Stokes equation, Integration of Euler's equation to obtain Bernoulli's equation, Bernoulli's theorem, Application of Bernoulli's theorem such as venturimeter, orificemeter, rectangular and triangular notch, pitot tube, orifices, etc.
c) Laminar Flow- Flow through circular pipe, between parallel plates, Power absorbed in viscous flow in bearings, loss of head due to friction in viscous flow.

Unit 5: Turbulent Flow and Dimensional Analysis [10 Hours]
a) Turbulent Flow**:** Reynolds's experiment, frictional loss in pipe flow, shear stress in turbulent flow, major and minor losses, HGL and TEL, flow through series and parallel pipes.

b) Dimensional Analysis:Dimensional homogeneity, Raleigh's method, Buckingham's theorem, Model analysis, similarity laws and dimensionless numbers.
d) Forces on Submerged bodies:Drag, lift, Drag on cylinder, Development of lift in cylinder.

Texts:

1. P. N. Modi, S. M. Seth, "Fluid Mechanics and Hydraulic Machinery", Standard Book House, 10th edition,1991.
2. Robert W. Fox, Alan T. McDonald, "Introduction to Fluid Mechanics", John Wile and Sons, 5thedition.

References:

1. V. L. Streeter, K. W. Bedfordand E. B. Wylie, "Fluid Dynamics", Tata McGraw-Hill, 9thedition, 1998.
2. S. K. Som, G.Biswas, "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw Hill, 2ndedition, 2003.

Thermodynamics & Heat Transfer

BTAC303	Thermodynamics& Heat Transfer	PCC 2	3L-1T-0P	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)

Course Contents:

Unit 1: Elementary Thermodynamics[08 Hours]

Basics of Thermodynamics, Ideal gas Laws, First Law of Thermodynamics, Steady Flow Energy Equation, Carnot Cycle, reverse Carnot Cycle, Second Law of Thermodynamics, Concept of refrigeration, Heat Pump and Heat Engine.

Unit 2: Vapor Power Cycles[08 Hours]

Vapour power cycles Steam Generation and its properties, Measurement of dryness fraction, Carnot Cycle, Application of Gas laws to vapour processes. Ideal Rankine Cycle, Calculation of Thermal Efficiency, Specific Steam Consumption, Work ratio.

Steam Turbines: Types, construction, working, compounding, velocity diagram, & diagram efficiency (No numerical).

Unit 3: Fuels and Fundamentals of Combustion[08 Hours]

Solid, Liquid and gaseous fuels, Combustion equations, analysis of product of combustion, gravimetric and volumetric analysis, theoretical air, excess air and exhaust gas produced.

Unit 4: I. C. Engines[08 Hours]

Air standard Otto, Diesel cycles(Elementary Numerical treatment), classifications of ICE and systems of I.C. engines such as fuel supply system for SI & CI engines, ignition system, cooling system, lubrication system, Performance of IC Engine –Indicated power, Brake power, Thermal efficiency, Specific fuel consumption(Elementary Numerical).

Unit 5: Heat Transfer[08 Hours]

Introduction and Basic Concepts of Conduction: Application areas of heat transfer in manufacturing and machine tools, Modes and Laws of heat transfer, thermal conductivity, thermal diffusivity, Heat conduction in plane wall, composite slab, composite cylinder, composite sphere, electrical analogy, concept of thermal resistance, overall heat transfer coefficient, conduction, critical radius of insulation for cylinders and spheres, economic thickness of insulation. (Elementary numerical)

Fundamentals of convection: Concept Laminar and turbulent flow, Reynold Number,

Prandlt number, Grashoff number, Nusselt Number. Mechanism of natural and forced convection, local and average heat transfer coefficient, concept of velocity & thermal boundary layers.

Fundamentals of Radiation: Fundamental concepts of radiation, different laws of radiation, Concept of: shape factor, radiation between two black and diffuse gray surfaces and radiation shields. (No numerical)

Texts:

1. R.K. Rajput, “Thermal Engineering”, Laxmi Publications.
2. R. S. Khurmi and Gupta, “Thermal Engineering”, S. Chand Publication.

References:

1. S.P. Sukhatme, “Heat Transfer”, Orient Longman.
2. Y.A. Cengel, “Thermodynamics – an Engineering approach” Tata McGraw Hill.
3. Eastop, A. Mc’conkey, “Applied Thermodynamics”, Pearson Publishers.
4. Holman J.P., “Heat Transfer”, Tata McGraw Hill.

Material Science and Metallurgy

BTMES304	Material Science and Metallurgy	ESC 10	3L-1T-0P	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1hr/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	Study various crystal structures of materials
CO2	Understand mechanical properties of materials and calculations of same using appropriate equations
CO3	Evaluate phase diagrams of various materials
CO4	Suggest appropriate heat treatment process for a given application
CO5	Prepare samples of different materials for metallography
CO6	Recommend appropriate NDT technique for a given application

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	1									
CO2	3	2	2	3	2							
CO3	2	1	2	1	1							
CO4	1	2	2	1	2	1	2	1	1	1		
CO5	1	1	1	3	2		1		1			
CO6	1	1	2	2	2	1	2		1	1		

All units carry 10 Marks each for End Semester Examination.

Course Contents:

Unit 1: Fundamentals

a) Structure of Materials [15 Hours]

Crystal structures, indexing of lattice planes, Indexing of lattice directions, Imperfections in crystals-point defects, line defects, surface and bulk defects, Mechanism of plastic deformation, deformation of single crystal by slip, plastic deformation of polycrystalline materials.

b) Mechanical Properties and their Testing

Tensile test, engineering stress-strain curve, true stress-strain curve, types of stress-strain curves, compression test, bend test, torsion test, formability, hardness testing, different hardness tests-Vickers, Rockwell, Brinnel, Impact test, fatigue test, creep test.

Unit 2: Equilibrium Diagrams[09 Hours]
Definitions of terms, rules of solid-solubility, Gibb's phase rule, solidification of a pure metal, plotting of equilibrium diagrams, lever rule, Iron-iron carbide equilibrium diagram, critical temperatures, solidification and microstructure of slowly cooled steels, non-equilibrium cooling of steels, property variation with microstructures, classification and application of steels, specification of steels, transformation products of austenite, TTTdiagram, critical cooling rate, CCT diagram.

Unit 3: Heat Treatment[07 Hours]
Heat treatment of steels, cooling media, annealing processes, normalizing, hardening, tempering, quenching and hardenability, surface hardening processes-nitriding, carbo-nitriding, flame hardening, induction hardening.

Unit 4: Metallographyn[08 Hours]
Microscopy, specimen preparation, polishing abrasives and cloths, specimen mounting, electrolytic polishing, etching procedure and reagents, electrolytic etching, optical metallurgical microscope, macroscopy, sulphur printing, flow line observations, examination of fractures, spark test, electron microscope.

Unit 5: Strengthening Mechanisms and Non-destructive Testing [08 Hours]
Refinement of grain size, cold working/strain hardening, solid solution strengthening, dispersion strengthening, Precipitation hardening. Magnetic particle inspection, dye Penetrant inspection, ultrasonic inspection, radiography, eddy current testing, acoustic emission inspection.

Texts:

1. V. D.Kodgire, S.V.Kodgire, "Material Science and Metallurgy for Engineers", Everest Publishing House, Pune, 24th edition, 2008.
2. W. D.Callister, "Materials Science and Engineering: An Introduction", John Wiley and Sons, 5th edition,2001.
3. V.Raghvan, "Material Science Engineering", Prentice Hall of India Ltd., 1992.

References:

1. V. B.John, "Introduction to Engineering Materials", ELBS, 6thedition, 2001.
2. G. F.Carter, D. E.Paul, "Materials Science and Engineering", ASM International, 3rd edition, 2000.
3. T. E.Reed-Hill, R.Abbaschian, "Physical Metallurgy Principles", Thomson, 3rdedition

Automotive ComponentDrawing&ComputerAided DraftingLab

BTACL305	Automotive ComponentDrawing& ComputerAided DraftingLab	PCC 3	0L-0T-4P	2 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: -- Practical:4 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	Interpret the object with the help of given sectional and orthographic views.
CO2	Construct the curve of intersection of two solids
CO3	Draw machine element using keys, cotter, knuckle, bolted and welded joint
CO4	Assemble details of any given part. i. e. valve, pump, machine tool part etc.
CO5	Represent tolerances and level of surface finish on production drawings
CO6	Understand various creating and editing commands in Auto Cad

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								3	2		1
CO2	2	1							2	1		1
CO3	2								2	1		
CO4	2	2			1				2	1		1
CO5	1	1			1				2	1		1
CO6	1	1			1				2	2		1

Course Contents:

Unit 1: Sectional Views[04 Hours]

Full section, half section, partial section, off-set section, revolved sections, removed sections,auxiliary section, guidelines for hatching, examples on all above types of sections ofmachine elements.

Unit 2: Study of Machine Elements[04 Hours]

Study of simple machine elements and components such as screwed fasteners, shaftcouplings, pipe joints, riveted and welded joints, bearings, gears, etc.

Unit 3: Interpenetration of surfaces (emphasis on applied cases)[04 Hours]

Line or curve of intersection of two penetrating cylinders, Cone and cylinder, prismand a cylinder, cone and prism, Forged ends, etc.

Unit 4: Drawing of Assembly and Details[04 Hours]

Part drawing of standard machine components such as valves, components of various machine tools, pumps, shaft couplings, joints, pipe fittings, engine parts, etc.

Unit 5: Production Drawing[04 Hours]

Types of production drawings, size, shape and description; limits, fits and tolerances,surface roughness and surface roughness symbols,

Computer Aided Drafting[04 Hours]

Introduction to Computer Aided Design and Drafting, Advantaged of CADD, study ofpreliminary AutoCAD commands like drawing, dimensioning, viewing commands.Drawing3D views in AutoCAD, Introduction to Auto LISP programming.

ListofPractical's/Experiments/Assignments:

1. One full imperial drawing sheet consisting the drawing/ sketches of representation of standard components, symbols of pipe joints, weld joints, rivet joint etc., surface finish symbols and grades, limit, fit and tolerance sketches.
2. Two full imperial drawing sheets, one consisting of assembly and the other consisting of details of any one standard component such as valves, components of various machine tools, pumps, joints, engine parts, etc.
3. Two assignments of AutoCAD: Orthographic Projections of any one simple machine component such as bracket, Bearing Housing or Cast component for Engineers such as connecting rod, Piston, etc.; with dimensioning and detailing of three views of components.
4. 3-D model at least one simple machine component

Texts:

1. N.D. Bhatt, Panchal, ―Engineering Drawing‖, Charotar Publishing House, Anand, India.
2. N.D. Bhatt, Panchal, ―Machine Drawing‖, Charotar Publishing House, Anand, India
3. Ajeet Sing, ―WorkingwithAutoCAD2000‖, Tata McGraw Hill, New Delhi.
4. George Omura, ―ABC of Autolispl , BPB Publications,New Delhi.

References:

1. Narayana, Kannaiah, Reddy, ―Machine Drawing‖, New Age International Publishers.
2. AutoCAD and AutoLISP manuals from Autodesk Corp. U.S.A.
3. ISCode: SP46-1988, Standard Drawing Practices for Engineering Institutes.

Automobile Engineering Lab I

BTACL306	Automobile Engineering Lab I	PCC 4	0L-0T-6P	3 Credits

Teaching Scheme:	Examination Scheme:
Lecture: 6hrs/week	Continuous Assessment: 60 Marks Mid Semester Exam: -- End Semester Exam: 40 Marks

Thermal Engineering Lab (PART –A)

List of Practicals/Experiments/Assignments (Any Three)
Any Three experiments from the list:

1. Determination of dryness fraction of steam.
2. Trial on bomb calorimeter.
3. Study of MPFI and Bosh fuel injection pump
4. Study of High Pressure Boilers.
5. Test on Diesel/Petrol engine to determine BP, bsfc, Brake thermal efficiency.
6. Trial on reciprocating air compressor.
7. Determination of thermal conductivity of insulating material.
8. Test on parallel & counter flow heat exchanger.
9. Determination of Emissivity of a Test Plate.

Material Science and Metallurgy Lab(PART –B)

List of Practicals/Experiments/Assignments (Any four experiments from the list)

1. Brinell Hardness Test
2. Rockwell Hardness test
3. Erichson Cupping Test
4. Magnaflux Test
5. Dye Penetrant Test
6. Specimen Preparation for Microscopy
7. Sulphur Print Test
8. Spark Test
9. Study and drawing of microstructures of plain carbon steels of varying carbon percentage
10. Study and drawing of microstructures of heat treated steels
11. Jominy End Quench Test
12. Study and drawing of microstructures of cast irons
13. Study and drawing of microstructures of non-ferrous alloys
14. Hardening of steels of varying carbon percentage

Fluid Mechanics Lab(PART –C)
List of Practical's/Experiments/Assignments (Any Three)

1. Flow visualization technique: characteristics of laminar and turbulent flow patterns using Helleshaw Apparatus.
2. Verification of Bernoulli's theorem
3. Determination of Critical Reynolds number using Reynolds Apparatus

4. Determinations of pressure drop in pipes of various cross-sections
5. Determinations of pressure drop in pipes of various pipe fittings etc.
6. Viscosity measurement using viscometer (at least one type)
7. Verification of momentum equation using impact of jet apparatus
8. Determination of meta-centric height of a floating body
9. Calibration of a selected flow measuring device and Bourdon pressure gauge

Gauge and differential pressure measurements using various types of manometers, Bourdon type pressure gauge. Demonstration of measurement using these instruments.

IT – 1 Evaluation

BTES209P (Internship – 1)	Internship – 1 Evaluation	PROJ-1	0L-0T-0P	1 Credits

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

Semester IV
Theory of AutomotiveEngines

BTAC401	Theory of Automotive Engines	PCC 4	3L-1T-0P	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3hrs/week	Continuous Assessment: 20 Marks

Tutorial: 1 hr/week	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	Perform a primary thermodynamic analysis of Otto and Diesel cycle.
CO2	Select appropriate engine for specific application.
CO3	Select proper fuel system and subsystemsfor I C Engine. Compare mechanisms for variable valve timing.
CO4	Conduct performance testing of the I C Engine and portray operating characteristics of I C Engines.
CO5	Select proper lubricant and lubrication system for engine
CO6	Understand the latest developments in IC Engines and alternate fuels.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Fundamentals of IC Engines[08 Hours]

Nomenclature, engine components, Engine classification, firing order and four stroke cycle engines; fundamental difference between SI and CI engines; valve timing diagrams.

Power Cycles: Air standard Otto, Diesel and Dual cycles; Valve timing diagrams, Fuel-Air cycles, deviation of actual cycles from ideal cycles.

Unit 2: Combustion[08 Hours]

Introduction, important qualities and ratings of SI and CI Engines fuels; Combustion in S.I. Engines, flame speed, ignition delay, normal and abnormal combustion, effect of engine variables on flame propagation and ignition delay, Combustion in C.I. Engines, combustion of a fuel drop, stages of combustion, ignition delay, combustion knock; types of SI and CI Engine combustion chambers.

Unit 3: Engine Valve Mechanism[08 Hours]

Theoretical and actual valve timing diagram for 2 stroke/ 4 stroke and Petrol/Diesel Engines, Conventional Valve Mechanisms, Mechanisms for variable valve timings.

Unit 4: Various Engine Systems[08 Hours]
Starting systems, fuel supply systems, engine cooling system, ignition system, engine friction and lubrication systems, governing systems.

Unit 5: Engine Testing and Performance of SI and CI Engines[12 Hours]
Parameters, Type of tests and characteristic curves, Effect of load and Speed on mechanical, indicated thermal, break thermal and volumetric efficiencies, Heat balance sheet.
Super charging in IC Engine: Effect of attitude on power output, types of supercharging.
Alternative Potential Engines
Stratified charge engine, VCR engine, Dual fuel engines, HCCI Engine, Green Engine,Engine Emissions & its effect on human being and environment. EURO and BHARAT emission norms,
Modern Trends in I C Engines.

Texts:

1. V.Ganeshan, "Internal Combustion Engines", Tata McGraw-Hill Publications, New Delhi, 3rd edition.

References:

1. J. B. Heywood, "Internal Combustion Engine Fundamentals", Tata McGraw Hill Publications, New York, International Edition, 1988.
2. ASHRAE Handbook, "Fundamentals and Equipment", 1993.
3. ASHRAE Handbook – Applications, 1961.
4. ISHRAE Handbook
5. Prof. Ram Gopal, NPTL Lectures, www.nptel.com, IIT Kharagpur.
6. Carrier Handbook
7. R.C. Jordan and G. B.Priester, "Refrigeration and Air Conditioning", Prentice Hall of India Ltd., New Delhi, 1969.
8. J. L.Threlkeld, "Thermal Environmental Engineering", Prentice Hall, New York, 1970.

Theory of Machines

BTPC402	Theory of Machines	PCC 6	3L-1T-0P	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3hrs/week Tutorial: 1hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks

	End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: Applied Mechanics and Engineering Graphics

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

CO1	Select appropriate mechanism to design and develop a machine for an application
CO2	Analyze the mechanisms to determine velocity and acceleration of various links of the mechanism
CO3	Design and draw profile of the cam to obtain specified follower motion for an application
CO4	Analyze the governor to determine its height for the corresponding change in speed and sleeve displacement
CO5	Explain lower pair mechanisms and select them to meet the need where they are suitable
CO6	Explain and apply friction concepts in automotive and mechanical applications.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1 [06 Hours]

Definition of link, pair, kinematics chain, inversions, inversions of single and double slider crank chain, kinematic diagrams of mechanisms, equivalent linkage of mechanism, degree of freedom, Study of various mechanisms, Steering system & mechanism, suspension.

Unit 2[06 Hours]

Velocity and acceleration analysis and its purpose, velocity and acceleration diagrams using relative velocity method, Corioli's component of acceleration, Velocity and acceleration analysis by vector methods, coordinate system, Loop closure equation, Chase solutions, velocity and acceleration by vector and complex algebra.

Velocity and acceleration of slider crank mechanism by analytical method and Klein's construction.

Unit 3[06 Hours]

Classification of gears, Terminology of spur gears, Conjugate action, Involute and cycloidal profile.Path of contact, contact ratio, Interference, Undercutting, Internal gears. Helical gear terminology, Normal and transverse module, Torque transmitted by helical gears, Spiral gears, Efficiency of spiral gears, Worm and Bevel gear terminology.

Gear Trains: Velocity ratios, Types of gear trains, Tooth load, Torque transmitted and holding torque.

Unit 4[06 Hours]
Cams and Followers: Types of cams and followers, Analysis of motion, Jump and ramp of cam, Determination of cam profiles for a given follower motion.

Flywheel: Turning moment diagram, Fluctuation of energy and speed, Determination of flywheel size for different types of prime movers and machines.

Governors: Function of governor, Inertia and centrifugal type of governors, Controlling force analysis, Governor Effort and governor power, Sensitivity, stability, Isochronisms andHunting, Friction insensitiveness.

Gyroscope: Principles of gyroscopic action, Precession and gyroscopic acceleration, gyroscopic couple, Effect of the gyroscopic couple on ships, aeroplanes and vehicles, inclined rotating discs, gyroscopic stabilization.

Unit 5 [10 Hours]
Friction Clutches: Principle, Functions, General requirements, Torque capacity, Types of clutches, Cone clutch, Single-plate clutch, Diaphragm spring clutch, Multi-plate clutch, Centrifugal clutch, Electromagnetic clutch, Lining materials, Over-running clutch, Clutch control systems.
Brakes& Braking System : Function and requirements of braking system, Types of brakes, Elementary theory of shoe brake, drum brake arrangement, disc brake arrangement, self-energizing, brake friction material. brake linkages, hydraulic brake system and components, hydraulic brake fluids, air brakes, vacuum servo assisted brake, engine exhaust brake, parking brakes, dual power brake system, regenerative brake system, fail-safe brake, anti – lock brakes, anti-skid brakes, brake efficiency and testing, weight transfer, braking ratio,ABS System.

Belt and Rope Drives: Flat belts, Effect of slip, Centrifugal tension, Crowing of pulley, Initial tension in belts. V- BeltsGeometric relationship,analysis ofbelttensions, conditionformaximumpower,Selectionof flatandV-beltsfrommanufacturer'scatalogue, Adjustment of belt tensions.

Text Books:
1. A.Ghosh and, A.K.Malik, "Theory of Mechanisms and Machines", Affiliated East-WestPress Pvt. Ltd., NewDelhi.
2. S. S. Rattan, "Theory of Machines", Tata-McGraw Hill, NewDelhi.

Reference Books:
1. Thomas Beven, "Theory of Machines", CBS Publishers and Distributors", Delhi.
2. J.E.Shigely and J.J. Uicker, "Theory of Machines and Mechanisms", McGraw Hill, NewYork, International Student Edition,1995

Basic Human Rights

BTHM403	Basic Human Rights	HSSMC3	3L-0T-0P	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 history of human rights.
CO2	Learn to respect others caste, religion, region and culture.
CO3	Be aware of their rights as Indian citizen.
CO4	Understand the importance of groups and communities in the society.
CO5	Realize the philosophical and cultural basis and historical perspectives of human rights.
CO6	Make them aware of their responsibilities towards the nation.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: The Basic Concepts [04 Hours]

Individual, group, civil society, state, equality, justice. Human Values, Human rights and Human Duties: Origin, Contribution of American bill of rights, French revolution. Declaration of independence, Rights of citizen, Rights of working and exploited people

Unit 2: Fundamental rights and economic program [04 Hours]

Society, religion, culture, and their inter-relationship. Impact of social structure on human behavior, Social Structure and Social Problems: Social and communal conflicts and social harmony, rural poverty, unemployment, bonded labour.

Unit 3: Workers and Human Rights[04 Hours]

Migrant workers and human rights violations, human rights of mentally and physically challenged. State, Individual liberty, Freedom and democracy.

Unit 4: NGOs and human rights in India [04 Hours]

Land, Water, Forest issues.

Unit 5: Human rights in Indian constitution and law [08 Hours]

i) The constitution of India: Preamble

ii) Fundamental rights.
iii) Directive principles of state policy.
iv) Fundamental duties.
v) Some other provisions.

UDHR and Indian Constitution

Universal declaration of human rights and provisions of India. Constitution and law.National human rights commission and state human rights commission.

Texts/References:

1. Shastry, T. S. N., "India and Human rights: Reflections", Concept Publishing Company India (P Ltd.), 2005.
2. C.J.Nirmal, "Human Rights in India: Historical, Social and Political Perspectives (Law in India)", Oxford India.

Strength of Materials

BTMES404	Strength of Materials	ESC11	3L-1T-0P	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks

Tutorial: 1hr/week	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 the basic definitions of fundamental terms such as axial load, eccentric load, stress, strain, E, μ, etc.
CO2	Recognize the stress state (tension, compression, bending, shear, etc.) and calculate the value of stress developed in the component in axial/eccentric static and impact load cases.
CO3	Distinguish between uniaxial and multi-axial stress situation and calculate principal stresses, max. shear stress, their planes and max. Normal and shear stresses on a given plane.
CO4	Analyze given beam for calculations of SF and BM
CO5	Calculate slope and deflection at a point on cantilever /simply supported beam using double integration, Macaulay's, Area-moment and superposition methods
CO6	Differentiate between beam and column and calculate critical load for a column using Euler's and Rankine's formulae

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Simple Stresses and Strains [12 Hours]

Mechanical properties of materials, analysis of internal forces, simple stresses and strains, stress-strain curve, Hooke's law, modulus of elasticity, shearing, thermal stress, Hoop stress, Poisson's ratio, volumetric stress, bulk modulus, shear modulus, relationship between elastic constants.

Principal Stresses and Strains

Uni-axial stress, simple shear, general state of stress for 2-D element, ellipse of stress, principal stresses and principal planes, principal strains, shear strains, strain rosettes, Mohr's circle for stresses and strains

Unit 2: Strain energy, resilience and Combined Stresses [10 Hours]

Strain energy, resilience: Combined axial and flexural loads, middle third rule, kernel of a section, load applied off the axes of symmetry.

Shear and Moment in Beams: Shear and moment, interpretation of vertical shear and

bending moment, relations among load, shear and moment.

Unit 3: Stresses in Beams[08 Hours]
Moment of inertia of different sections, bending and shearing stresses in a beam, theory of simple bending, derivation of flexural formula, economic sections, horizontal and vertical shear stress, distribution shear stress for different geometrical sections-rectangular, solid circular, I-section, other sections design for flexure and shear.

Unit 4: Torsion[08 Hours]
Introduction and assumptions, derivation of torsion formula, torsion of circular shafts, stresses and deformation indeterminate solid/homogeneous/composite shafts, torsional strain energy.
Columns and Struts: Concept of short and long Columns, Euler and Rankine's formulae, limitation of Euler's formula, equivalent length, eccentrically loaded short compression members.

Unit 5: Beam Deflections[08 Hours]
Differential equation of deflected beam, slope and deflection at a point, calculations of deflection for determinate beams by double integration, Macaulay's method, theorem of area-moment method (Mohr's theorems), moment diagram by parts, deflection of cantilever beams, deflection in simple supported beams, mid-span deflection, conjugate beam method, deflection by method of superstition.

Texts:
1. S. Ramamrutham, "Strength of Materials", DhanpatRai and Sons, New Delhi.
2. F. L. Singer, Pytle, "Strength of Materials", Harper Collins Publishers, 2002.
3. S. Timoshenko, "Strength of Materials: Part-I (Elementary Theory and Problems)", CBS Publishers, New Delhi.

References:
1. E. P.Popov, "Introduction to Mechanics of Solid", Prentice Hall, 2nd edition, 2005.
2. S. H. Crandall, N. C. Dahl, T. J. Lardner, "An introduction to the Mechanics of Solids", Tata McGraw Hill Publications, 1978.
3. S. B. Punmia, "Mechanics of Structure", Charotar Publishers, Anand.

Elective I
Automotive Materials

BTAPE405A	Automotive Materials	PEC 1	3L-0T-0P	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: Material science and metallurgy

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

CO1	The student shall gain appreciation and understanding Material properties chart and all parameters of chart.
CO2	Shall be able to know different types of electric and magnetic materials also non-metallic materials.
CO3	Student shall gain knowledge of various surface treatment used in automobile industries
CO4	Student shall gain knowledge of modern materials comes such as shape memory alloy etc.
CO5	Ability to select material of material from the material properties chart with considering such parameter modulus density, strength density and modulus strength.
CO6	Ability to select material for the automotive components

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit-I: Material Property Charts and Selection Criteria

Material Property Charts: Modulus-density, strength-density, modulus strength, specific stiffness and specific strength, fracture toughness, modulus fracture.

Selection Criteria- Shape factor, elastic extrusion, elastic body and twisting, failure, bending and twisting, efficiency of standard sections, material limits and shape factors.

Unit-II:Polymers

Physical and Mechanical properties of polymers and their composites, effect of processing on properties. Applications in engineering.

High Polymers: Classification of High polymers- production of high polymers- general methods- Some important plastics, their production, properties and uses- Polyethylene

PVC, Polystyrene, Teflon, Acrylics, Nylon, Polyesters, Phenol Formaldehyde Resins, Urea Formaldehyde Resins and silicones-compounding and moulding of High polymers.

Unit-III: Composite Materials
Composite Materials: Introduction, Types of composite materials, properties, advantages, orthotropic and anisotropic behaviour, Micromechanical and micromechanical analysis of composite material, Applications of composite materials

Unit-IV: Surface Modification of Materials
Mechanical surface treatment and coating - case hardening and hard facing, thermal spraying, vapor deposition, ion implantation, diffusion coating, electroplating and electro-less, conversion coating, ceramic and organic coatings, diamond coating.

Unit-V: Modern Materials and Alloys
Super alloys, refractory metals, shape memory alloys, dual phase steels, micro alloyed, high strength low alloy steel, transformation induced plasticity (trip) steel, merging steel, smart materials, metallic glass, quasi crystal and Nano crystalline materials., metal foams.
Materials selection for automotive components : Criteria of selecting materials for automotive components viz cylinder block, cylinder head, piston, piston ring, gudgeon pin, connecting rod, crank shaft, crank case, cam, cam shaft, engine valve, gear wheel, clutch plate axle, bearings, chassis, spring, body panel - radiator, brake lining etc. application of non-metallic materials such as composite, ceramic and polymers in automobile.

Reference Books:

1. "Material Science and Engineering- An introduction", Callister W.D. (2006), Wiley – Eastern.
2. "Physical Metallurgy", Raghavan, V., (2003), Prentice Hall of India.
3. "Materials Selection in Mechanical Design", Michael F. Ashby, Butterworth Heinemann,2005.
4. "Mechanical Behavior of Materials", Thomas H. Courtney, (2000) McGraw Hill.
5. "Engineering Materials and their Applications", Flinn R. A. and Trojan P. K. (1999), Jaico.
6. "Surface Engineering for wear resistance", Kenneth Budinski– (1988) Prentice Hall.
7. "Introduction to physical metallurgy", Avner S.H., (2006) –Tata McGraw Hill.
8. Materials Science and Metallurgy", DanielYesudianC, Scitech Publications (Indian ,2004.)

Alternative Fuels for IC Engine

BTAPE405B	Alternative Fuels for IC Engine	PEC 1	3L-0T-0P	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	Modify automotive engine to operate by using various alternative fuels.
CO2	Analyze engine performance and emission characteristics by using alternative fuels.
CO3	Suggest advance engine technology for alternative fuels.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit-1:
Conventional Fuels and Need for alternative fuels
Need for alternative fuels, applications, various alternate fuels etc.
Comparison of properties of fuels, quality rating of SI and CI engine fuels, fuel additives for SI and CI engines,

Unit-2:
Alternative Fuels I – Gaseous Fuels
Introduction to CNG, LPG, Study of availability, manufacture, properties, storage, handling and dispensing, safety aspects, and engine/vehicle modifications required.

Unit-3:
Biofuels
Biodiesel, Biogas, ethanol, Methanol. Study of availability, manufacture, properties, storage, handling and dispensing, safety aspects, engine/vehicle modifications required.

Unit–4:
Hydrogen
Study of availability, manufacture, properties, storage, handling and dispensing, safety aspects, engine/vehicle modifications required.

Unit-5:
Fuel Cell Technology
Operating principles, Types, construction, working, application, advantages and limitations.

Texts:

1. AyhanDemirbas, "*Biodiesel A Realistic Fuel Alternative for Diesel Engines*", Springer-Verlag London Limited 2008, ISBN-13: 9781846289941

References:

1. “Alternative Fuels”, Dr. S. S. Thipse, Jaico publications.
2. “Engine Emission”, B.P Pundir, Narosa publication.
3. “Internal Combustion Engines”, V. Ganesan, Tata McGraw Hill.
4. “Automotive Emission Control”, Crouse, W.M. and. Anglin, A.L, McGraw Hill.
5. “IC Engines”, Dr. S. S. Thipse, Jaico publications.
6. “Engine Emissions, pollutant formation”, G. S. Springer and D.J. Patterson, Plenum Press.
7. ARAI vehicle emission test manual.
8. Gerhard Knothe, Jon Van Gerpen, Jargon Krahl, “The Biodiesel Handbook”, AOCS Press
   Champaign, Illinois 2005.
9. Richard L Bechtold P.E., Alternative Fuels Guide book, Society of Automotive Engineers,
   1997, ISBN 0-76-80-0052-1.
10. Transactions of SAE on Biofuels (Alcohols, vegetable oils, CNG, LPG, Hydrogen, Biogas etc.).
11. Science direct Journals (Biomass & Bio energy, Fuels, Energy, Energy conversionManagement, Hydrogen Energy, etc.) on biofuels.
12. Devaradjane. Dr. G., Kumaresan. Dr. M., "Automobile Engineering", AMK Publishers, 2013.

Numerical Methods in Mechanical Engineering

BTMPE405A	Numerical Methods in Mechanical Engineering	PEC1	3L-0T-0P	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)

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

CO1	Describe the concept of error
CO2	Illustrate the concept of various Numerical Techniques
CO3	Evaluate the given Engineering problem using the suitable Numerical Technique
CO4	Develop the computer programming based on the Numerical Techniques

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		1	3							
CO2	3	3		1	3							
CO3	3	3		1	3							
CO4	3	3		1	3							

Course Contents:

Unit1: ErrorAnalysis[06 Hours]

Significant figures, round-off, precision and accuracy, approximateand true error, truncation error and Taylor series, machine epsilon, data uncertainties, error propagation, importance of errors in computer programming.

Unit2: Roots of Equations[06 Hours]

Motivation, Bracketing methods: Bisection methods, Open methods: Newton Raphson method,Engineeringapplications.

Unit3: NumericalSolutionofAlgebraicEquations[06 Hours]

Motivation, Cramer'srule,Gauss- EliminationMethod,pivoting,scaling, engineeringapplications.

Unit4: NumericalIntegrationandDifferentiation[06 Hours]

Motivation,Newton's CotesIntegrationFormulas:TrapezoidalRule,Simpson'srule,engineeringapplications NumericaldifferentiationusingFinitedivideDifferencemethod

Unit5: Curve, Fitting andInterpolation and Computer Programming [12 Hours]

Motivation,LeastSquareRegression: LinearRegression, Polynomialregression.

Interpolation: Newton'sDivideDifferenceinterpolation,engineeringapplications.

SolutiontoOrdinaryDifferentiation

Equations: Motivation**,**Euler'sandModifiedEuler'sMethod,Heun'smethod,Runge–KuttaMethod,engineeringapplications.

ComputerProgramming

Overview of programming language, Developmen to fatl east one computer program based on each unit.

Texts:

1. StevenCChapra,ReymondP.Canale, "NumericalMethodsforEngineers",TataMcGraw Hill Publications,2010.
2. E.Balagurusamy, "NumericalMethods",TataMcGraw HillPublications,1999.

References:

1. V. Rajaraman, "FundamentalofComputers",PrenticeHallofIndia,NewDelhi,2003.
2. S. S. Sastri,"IntroductoryMethodsofNumericalMethods",PrenticeHallofIndia,NewDelhi, 3rd edition,2003.
3. K. E. Atkinson, "AnIntroductionto NumericalAnalysis",Wiley,1978.
4. M.J. Maron, "Numerical Analysis: A Practical Approach", Macmillan, New York, 1982

Sheet Metal Engineering

BTMPE405B	Sheet Metal Engineering	PEC 1	3L-0T-0P	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	Recognize common manufacturing processes of Sheet Metal Fabrication
CO2	Understand the principles of design and fabricate of sheet metal products and recognize common material used in the industry
CO3	Distinguish Shearing, Drawing and Pressing etc. processes.
CO4	Know types of dies and formability.
CO5	Select mechanical or hydraulic presses for the given process

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	3	2				2	1		1
CO2	3			1	3	2	3					2
CO3	1	1		3	3	2	1		3		1	3
CO4	3	3	1	1	3		1	1	1			
CO5	3	2			3	3	2				1	3

Course Contents:

Unit1: Introduction
Importanceofsheetmetalengineering,materialsused,desirableproperties ofmaterialsin sheet metalproducts

Unit2: BasicApplications
Shearingprocesseslikeblanking,piercing,andpunching.

Unit3: DrawingProcesses
Shallowanddeepdrawingofcylindricalandrectangularbodies,
formingandbendingincludingspring-back.

Unit4: TypesofDies and Mechanical Presses
Dies:Compounddies,progressivedies,andcombinationdies
Mechanical Presses
Mechanicalandhydraulicpresses,modern developmentsinpresstools, formability.

Unit 5: Case Studies
Casestudiesformanufacturingofsheet metalproductsinvariousengineeringapplications

Texts:

1. Donaldson et al., “Tool Design”, Tata McGraw-Hill Publications, New Delhi, 1998.

References:

1. P.N.Rao,"ManufacturingTechnology,Foundry,FormingandWelding",Vol.I,Tata McGraw Hill Publishing Co. Ltd, New Delhi, 3rd edition, 2004.
2. ASMHandbook, "MetalForming",Vol.XV,ASMPublication,Metals Park, Ohio,10th edition,1989.
3. A. S.Deshpande, "DieDesignHandbook",ASTME.
4. SheetMetalEngineeringNotes,IITBombay,1999.

Fluid Machinery

BTMPE405C	Fluid Machinery	PEC 1	3L-0T-0P	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 and apply momentum equation
CO2	Understand and explain Hydrodynamic Machines
CO3	Explain difference between impulse and reaction turbines
CO4	Find efficiencies, draw velocity triangles
CO5	Explain governing mechanisms for hydraulic turbines
CO6	Explain working of various types of pumps, draw velocity diagrams, do simple calculations
CO7	Design simple pumping 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	3	2	1									1
CO2	3		3				2					1
CO3	3	2										1
CO4	3	3	2									1
CO5			3									1
CO6	3	3	3	1	1							1
CO7	3	3		3								1

Course Contents:

Unit 1: Momentum Equation and its Applications

Impulse momentum, Principle, Fixed and moving flat inclined plates, Curved vanes, Series of plates and vanes, Velocity triangle and their analysis, Water wheels. Hydrodynamic Machines: Classification, General theory, Centrifugal head, Fundamental equations, and Euler's equation, Degree of reaction, Head on machine, various efficiencies, Condition for maximum hydraulic efficiency.

Unit 2: Impulse Turbines

Impulse principle, Construction of Pelton wheel, Velocity diagrams and its analysis, Number of buckets, Jets, Speed ratio, Jet ratio.

Reaction Turbines: Constructional details of Francis, Kaplan and Propeller turbine, Deciaz turbine, and Draft tube types, Efficiencies, Cavitation.

Unit 3: Governing of Turbines

Methods of governing, Performance characteristics, Safety devices, Selection of turbines, Unit quantities, Specific speed, Principles of similarity and model testing.

Unit 4: Centrifugal Pump

Construction, Classification, Terminology related to pumps, Velocity triangle and their analysis, Cavitation, NPSH, Thoma's cavitation factor, Priming, Methods of priming, Specific speed,

Performance characteristics, Actual thrust and its compensation, Troubleshooting.
Multistage Pumps: Pump H-Q characteristics and system H-Q Characteristics, Series and parallel operation of pumps, Systems in series and parallel, Principle of model testing and similarity.

Unit 5: Special Purpose Pumps
Chemical pumps, nuclear pumps, Sewage pumps, Submersible deep well pumps, Pump installation, Energy efficient pumps.
Failure of Pumping System: Pump failures, Remedies, Source failure, Causes and remedies, Trouble shooting.
Miscellaneous Pumps: Reciprocating pump, Gear pump, Vane pump, Lobe pump, etc., Application field (no mathematical treatment).

Texts:

1. P. N. Modi, S. M. Seth, "Hydraulics and Fluid Mechanics including Hydraulic Machines", Standard Book House, Rajsons Publications Pvt. Ltd., 20th edition.
2. R. K. Bansal, "A Text Book of Fluid Mechanics and Hydraulic Machines", Lakshmi Publications Pvt. Ltd., 9th edition.

References:

1. Yunus A. Çengel, John M. Cimbala, Fluid Mechanics: Fundamentals and Applications", McGraw Hill, 3rd edition, 2014.

Automobile Engineering Lab II

BTACL406	Automobile Engineering Lab II	PCC 7	0L-0T-6P	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 6hrs/week	Continuous Assessment: 60 Marks

	Mid Semester Exam: -- End Semester Exam: 40 Marks(Duration 03 hrs)

Theory ofMachinesLab (Part A)

ListofPractical's /Experiments/Assignments

1. **Four sheets** (half imperial size)
   Graphical solution of problems on velocity, acceleration in mechanisms by relative, velocity method, instantaneous centre of rotation method and Klein's construction. At least one problem containing Coriolis component of acceleration.

2. **Experiments (Any2)**
   a) Experimental determination of velocity and acceleration of Hooke's joint.
   b) Determination of displacement of slider-crank mechanism with the help of model and to plot velocity and acceleration curves from it.
   c) Experiment on Coriolis component of acceleration.

Strength of Material Lab (Part B) (Any Four)

List of Practicals/Experiments/Assignments (any Four experiments from the list)

1. Tension test on ferrous and non-ferrous alloys (mid steel/cast iron/aluminum, etc.
2. Compression test on mild steel, aluminum, concrete, and wood
3. Shear test on mild steel and aluminum (single and double shear tests)
4. Torsion test on mild steel and cast iron solid bars and pipes
5. Flexure test on timber and cast iron beams
6. Deflection test on mild steel and wooden beam specimens
7. Graphical solution method for principal stress problems
8. Impact test on mild steel, brass, aluminum, and cast iron specimens
9. Experiments on thermal stresses
10. Strain measurement in stress analysis by photo-elasticity
11. Strain measurement involving strain gauges/ rosettes
12. Assignment involving computer programming for simple problems of stress, strain computations.

Theory of Automotive Engines Lab (Part C)

List of Practical's/Experiments/Assignments

A. Demonstration of physical systems in terms of constructional details and functions

1. 2 Stroke and 4 Stroke Engines
2. Carburetor.
3. Ignition system.
4. Fuel injection system.
5. Cooling System
6. 2 stage / 3 stage pressurised gas supply system. (LPG/CNG/Biogas/Hydrogen)
7. Visit to Industry related to automotive service station.

B. I C Engines (Any **TWO** experiments from the list)

1. Trial on Diesel engine- variable speed/load test and energy balance.

2. Trial on Petrol engine- variable speed/load test and energy balance.
3. Trial on Petrol Engine- Morse Test.
4. Measurements of exhaust emissions of Petrol engine / Diesel engine.
5. Heat Balance test on diesel or petrol engines.
6. Experimental determination of Air fuel ratio.

SEMESTER V
Design of Machine Elements

BTPC501	Design of Machine Elements	PCC 8	3L-1T-0P	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)

Objectives: To understand material properties, design process and various theories of failures in order to design various basic machine components and new components based on design principles.

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:

Unit1:

MechanicalEngineeringDesignProcess

Traditionaldesignmethods, generalindustrialdesign procedure,designconsiderations, phasesindesign, creativity indesign,useofstandardization, preferredseries,introduction toISO9000,useofdesigndatabook,aestheticandergonomic considerationsindesign.

Theories of Failure: Maximum normalstresstheory,Maximumshearstresstheory,Maximumdistortion energytheory,comparison ofvarioustheoriesoffailure,

Unit2:DesignofMachineElements

Against StaticLoading

Directloadingandcombinedloading,Jointssubjectedtostaticloadinge.g.cotterandknucklejoint,turnbuckle,etc.introduction to fluctuatingloads.

II: Against Fluctuating Loads

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 3:DesignofShafts, Keys, Couplings and Bearings

Variousdesignconsiderations intransmissionshafts, splined shafts, spindle and axlesstrength, lateral and torsional rigidity, ASME code for designingtransmissionshaft.

TypesofKeys: Classificationandfitmentinkeyways,Designofvarioustypesofkeys.

Couplings: Designconsideration,designofrigid,muffandflangetypecouplings, designof flexiblecouplings.

Bearings: Types, Constructional details of roller contact and sliding contact bearings, Static

and dynamic load carrying capacities, Stribeck'sEquation, Equivalent load, loadandlife relationship, selection ofbearinglife, Load factor,selection of bearing from manufacturer's catalogue, Lubrication and bearing materials.

Unit 4:DesignofThreaded Joints

Stressesinscrewfasteners,boltedjointsundertension,torquerequirementforbolttightening,preloadingofboltunderstaticloading,eccentricallyloaded boltedjoints.

PowerScrews: Formsofthreadsusedforpowerscrewandtheirapplications,torqueanalysisforsquareandtrapezoidalthreads,efficiencyofscrew,collarfriction,overallefficiency,self-lockinginpowerscrews,stressesinthepowerscrew,designofscrewandnut,differentialandcompound screw,re-circulatingballscrew.

Welded Joints: Typeofweldedjoints,stressesinbuttandfilletwelds,strength ofweldedjoints subjectedtobendingmoments.

Mechanical Springs

Stressdeflectionequationforhelicalspring,Wahl'sfactor,styleofends, designofhelicalcompression, tensionandtorsionalspringunderstaticloads,constructionand designconsiderationinleafsprings,nipping

Unit 5:Design of Gears and Drives

Geardrives, Classification ofgears, Lawofgearing,Terminology ofspurgear, Standard system of geartoothforceanalysis,geartoothfailures,material selection,Numberofteeth,Facewith,Beamstrengthequation,Effectiveloadongear tooth,Estimation ofmodulebasedonbeamstrength.

Design formaximumpowercapacity, Lubricationofgears.

HelicalGears: Terminology,Virtualnumberofteeth,Toothproportions,Forceanalysis,Beam strengthequation,Effectiveloadongeartooth,Wearstrengthequation.

BevelGears: Typesofbevelgears,Terminologyofstraightbevel,forceanalysis,BeamandWearstrength,Effectiveloadongeartooth.

WormGears: Terminology,Proportions,Forceanalysis,Frictionin wormgears,Vectormethod, Selectionofmaterials,Strengthandwearrating,Thermalconsiderations

Texts:

1. V. B.Bhandari, "DesignofMachineElements",TataMcGrawHill Publications,NewDelhi,2008.
2. R. L.Nortan, "MachineDesign:AnIntegratedApproach",PearsonEducationSingapore, 2001.

References:

1. R. C.Juvinall, K. M.Marshek, "Fundamentalofmachinecomponentdesign",John Wiley&SonsInc.,NewYork,3rdedition,2002.
2. B. J. Hamrock,B. JacobsonandSchmidSr., "FundamentalsofMachineElements", InternationalEdition,NewYork,2ndedition,1999.
3. A. S.Hall,A. R.Holowenko, H. G.Langhlin,"TheoryandProblemsofMachine Design",Schaum'sOutlineSeries, Tata McGrawHillbookCompany,NewYork,1982.
4. J. E.ShigleyandC.Mischke, "MechanicalEngineeringDesign", Tata McGrawHill Publications,7thedition, 2004.
5. M. F.Spotts, "DesignofMachineElements",PrenticeHallofIndia,NewDelhi.

Automotive Chassis, Suspension & Transmission Systems

BTAC502	Automotive Chassis, Suspension&Transmission Systems	PCC 9	3L-1T-0P	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3hrs/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	Elaborate the constructional details and operations of chassis systems like steering system, suspension system etc.
CO2	Interpret the underlying mechanics of the chassis systems.
CO3	Apply steering geometry for a given vehicular application.
CO4	Select/Configure components or subsystems for integration into main chassis system.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit-I: Vehicle Chassis
Introduction To chassis, chassis operating condition, chassis frame, vehicle components location. Manufacturing processes for chassis, causes of chassis failure

Unit-II: Vehicle Suspension Systems
Road irregularities and need of suspension system, Types of suspension system, Sprung and unspring mass, Suspension springs – requirements, types and characteristics of leaf spring, coils spring, rubber spring, air and torsion bar springs, Independent suspension for front and rear, Types, Hydro-elastic suspension, roll center, use of anti-roll bar and stabilizer bar, Shock absorbers – need, operating principles and types, Active suspension.

Unit – III
Gear Box
Gear Box: Necessity of gear box, Resistance to motion of vehicle, Requirements of gear box, Functions of gear box, Types- Sliding mesh, Constant mesh, Synchromesh. Principle, construction and working of synchronizing unit, Requirements &applications of helical gears, Gear selector mechanism, Two-wheeler gear box, Lubrication of gear box, Overdrive gears, Performance characteristics.
Drive Lines
Propeller shaft-universal joints, hooks and constant velocity U.J., Drive line arrangements – Hotchkiss drive & torque tube drive, Rear wheel drive, front wheel drive and four-wheel drive layouts and its advantages & limitations.

Unit – IV
Final Drive & Rear Axle
Purpose of final drive & drive ratio, Different types of final drives, need of differential, Constructional details of differential unit, Differential lock, Differential housing, Function of rear axle, Construction, Types of loads acting on rear axle, Axle types - semi-floating, full floating, three quarter floating.

Fluid Flywheel, Torque convertor, Epicyclic Gear Boxes
Fluid Flywheel, Torque convertor: Operating principle, Construction and working of fluid flywheel, Characteristics, Advantages& limitations of fluid coupling, Torque convertor, and construction and working of torque converter, Performance characteristics, Comparison with conventional gear box.Epicyclic Gear Boxes: Simple epicyclic gear train, Gear ratios, Simple

&compound planet epicyclic gearing, Epicyclic gearboxes, Wilson epicyclic gear train - Construction and operation, Advantages, Clutches and brakes in epicyclic gear train, compensation for wear, performance characteristics.

Unit –V

Automatic Transmission

Principle of semi-automatic & automatic transmission, Hydromantic transmission, Fully automatic transmission, Semi-automatictransmission, Hydraulic control system, Continuous variable transmission (CVT) – operating principle, basic layout andoperation, Advantages and disadvantages.

Text Book:

1. "Automobile Engineering" R. B. Gupta SatyaPrakashan New Delhi.
2. "Basic Automobile Engineering" C. P. NakraDhanpatRai Publishing Company (P) Ltd-New Delhi
3. "Automotive Mechanics" N.K. Giri 8th Edition Khanna Publishers New Delhi.
4. Dr. Kripal Singh, "Automobile Engineering-Vol. 1", 13th Edition, Standard Publishers Distributors
5. N. K. Giri, "Automotive Mechanics", Khanna Publishers, Delhi, Eighth Edition

References:

1. "Motor Vehicles", Newton, Steed and Garrot, 13th Edition, Butterworth London
2. "Vehicle and Engine Technology", Heisler, Second Edition SAE International Publication.
3. "Advanced Vehicle Technology", Heisler,Second Edition SAE International Publication.
4. "The Automotive Chassis", J. Reimpell H. Stoll, J.W. Betzler, SAE International Publication.
5. Newton, Steed &Garrot, "Motor Vehicles", 13th Edition, Butterworth London
6. A. W. Judge, "Modern Transmission", Chapman & Hall Std., 1989
7. Chek Chart, "Automatic Transmission", A Harper & Raw Publications
8. J. G.Giles, "Steering, Suspension & Tyres", – Lliffe Book Ltd., London
9. W. Steed, "Mechanics of Road Vehicles", Lliffe Book Ltd
10. Heisler, "Vehicle and Engine Technology", Second Edition, SAE International Publication

Manufacturing Processes

BTAC503	Manufacturing Processes	PCC10	3L-1T-0P	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 castings processes, working principles and applications and list various defects in metal casting
CO2	Understand the various sheet metal processes, working principles and applications
CO3	Classify the basic joining processes and demonstrate principles of welding, brazing and soldering.

CO4	Study center lathe and its operations including plain, taper turning, work holding devices and cutting tool.
CO5	Understand milling, drilling, boring, shaping and broaching operations
CO6	Describe the mechanical measurements techniques

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Introduction to Manufacturing

What is manufacturing? Examples of manufacturing products, Classification of manufacturing processes, Selection of materials, Types of manufacturing strategies.Importanceofsheetmetalengineering,materialsused,desirableproperties ofmaterialsin sheetmetalproducts.Shearingprocesseslikeblanking,piercing,andpunching.

Unit 2: Metal Casting Processes

Patterns, allowances, moulding sand properties and preparation, Cores, core prints, sand moulding procedure, Gating and riser design, melting practice and furnaces, solidification of metals, casting defects and inspection, Specialized casting processes such as shell mould casting, die casting, centrifugal casting, investment casting and permanent mould casting.

Unit 3: Joining Processes

Gas welding, gas cutting, Electric arc-welding with consumable and non-consumable electrodes (MMAW, GMAW, TIG, and SAW); solid state welding: resistance welding, spot and seam welding, thermit welding, friction welding, welding defects, Brazing and soldering.

Unit 4: Turning, Shaping, Milling and Planing

Lathe and its types, constructional features, lathe operations, taper turning, methods of taper turning, work holding and cutting tool, thread cutting, machining time and power estimation, shaper, Milling machine and its types, construction, milling operations, milling cutters, Planing machine sand their types and operations.

Unit 5: Drilling, Boring, Broaching

Drilling machine, its types, construction, twist drill, drilling time and power estimates, counter boring, spot facing, boring, reaming, tapping, and broaching, broach tool, broaching machine types, construction and operations.

Mechanical Measurements

Introduction to measurements, Errors in measurements, Measurement of temperature, pressure, velocity, Measurement of heat flux, volume/mass flow rate, Measurement of thermo-physical

properties, radiation properties of surfaces, vibration and noise,Measurement of length, measurement of angle, Measurement of geometric forms, straightness, flatness, roundness

Texts:

1. P. N. Rao, "Manufacturing Technology, Foundry, Forming and Welding", Vol. 1, 3rd edition, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 2004.
2. P.N. Rao, "Manufacturing Technology, Metal Cutting and Machine Tools", Vol. 2, 2nd edition, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 2002.
3. Gayler J.F. and Shotbolt C.R. Metrology for Engineers, ELBS, Fifth Edition 1990

References:

1. M. P. Groover, "Fundamentals of Modern Manufacturing: Materials, Processes and Systems", Prentice Hall, Upper Saddle River, New Jersey, 1999.
2. S. Kalpakjian and S.R.Schmid, "Manufacturing Engineering and Technology", Addison Wesley Longman (Singapore) Pte. India Ltd., 4th edition, 2000.

Elective II
Automobile Design (Product Design, PLM, CAE, Catia)

BTAPE504A	Automobile Design (Product Design, PLM, CAE, Catia)	PEC 2	3L-0T-0P	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	
CO2	
CO3	
CO4	

CO5	
CO6	

Mapping of course outcomes with program outcomes

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

Course Contents:

Domain related training (Approx. 20 Hrs)

Unit 1:

Introduction to Styling, Basic of Design - Introduction to Design, Good Design & it's Examples of All Time, Industrial Design & its use. Design Process - Typical Product Life Cycle, Automotive Design Process (for production release), Design Studio (Automotive studio) Process or Product Conceptualization Process, Case Study. CAS Surfaces or Digital Clay Models, Class A Surfaces - Role of Class A surface Engineer, Requirements for a Surface to fulfill " Class A Surface" Standards, Case Studies for Class A Surfaces, Class A Surface Creation for Bonnet

Unit 2:

Introduction to Body In White: Introduction & familiarization to Body In White (BIW), various type of BIW, Types of BIW sub system, various aggregates of BIW. Bonnet Design Case Study:Function of Bonnet, Defined Input to Bonnet, Intended Input to Bonnet Design. Steps in Bonnet design, Study of Class A Surfaces, Hood Package Layout , Typical Sections, Block Surfaces in 3D, Dynamic Clearance Surfaces in 3D, Hood Structural Members, CAE 1(Durability, Crash), Panel Detail Design, Body Assembly Process, CAE 2(Durability, crash, individual panel level), Design Updating & Detailing Prototypes, Design Updating & Production Release

Unit 3:

Introduction to CAE & its importance in the PLM, Introduction to FEA & its applications (NVH, Durability & Vehicle Crashworthiness). Introduction of Pre-Processor, Post-Processor & Solvers. Importance of discretization & Stiffness Matrix (for automobile components). Importance of oil canning on an automobile hood with Case study related to Durability Domain. Modal analysis on the hood (Case Study related to NVH Domain). Introduction of vehicle crashworthiness & Bio-mechanics (Newtonian laws, energy management, emphasis of impulse in car crashes). Head impact analysis as a Case study on the hood of an automobile (EuroNCAP test regulation). Importance of Head performance criteria (HPC). Introduction to failure criteria (By explaining the analogy of using uni-axial test results for predicting tri-axial results in reality), Mohr's Circle, Von-Mises stress criteria, application of various failure criteria on brittle or ductile materials

Unit 4:

Introduction to CAD,CAM & CAE, FEA - Definition, Various Domains – NVH, Dura,

Crash, Occupant Safety, CFD. Implicit vs. Explicit Solvers, Degree of Freedom, Stiffness Matrix, Pre-Post & Solver; Types of solvers, Animation. Durability -Oil Canning, Oil Canning on Hood, Scope of work, Loading, Boundary Conditions, Results & Conclusions. NVH – Constrained Modal Analysis, Constrained Modal Analysis on Hood, Scope of work, Loading, Boundary Conditions, Results & Conclusions. Crash – Vehicle Crashworthiness, Energy Management, Biomechanics, Head Impact Analysis on Hood, Importance of Failure Criteria, Von-Mises Stress

Unit 5:

Sheet metal design & Manufacturing Cycle, Simultaneous Engineering (SE) feasibility study, Auto Body & its parts, important constituents of an automobile, sheet metal, sheet metal processes. Type of draw dies, Draw Model development & its considerations. Forming Simulations, Material Properties, Forming Limit Curve (FLD), Pre Processing, Post-Processing, Sheet metal formability- Simulation

Die Design –Sheet metal parts, Sheet metal operations (Cutting, Non-Cutting etc.), Presses, Various elements used in die design, Function of each elements with pictures, Types of dies, Animation describing the working of dies, Real life examples of die design. **Fixture Design -** Welding (Spot/Arc Welding), Body Coordinates, 3-2-1 principle, Need for fixture, Design considerations, Use of product GD&T in the fixture design, fixture elements. Typical operations in Sheet metal Fixture (Manual/Pneumatic/Hydraulic fixture), Typical unit design for sheet metal parts (Rest/Clamp/Location/Slide/Dump units/Base), Types of fixture (Spot welding/ Arc welding/ Inspection fixture/Gauges)

Tools related training (Approx. 20 Hrs):

Depending on the tools available in the college, the relevant tool related training modules shall be enabled to the students.

AutoCAD, AutoCAD Electrical, AutoCAD Mechanical, AutoCAD P&ID, Autodesk 3ds Max, Autodesk Alias, Autodesk SketchBook, Automotive, CATIA V5, CATIA V6, FEA, Autodesk Fusion 360, Autodesk Inventor, Autodesk Navisworks, Autodesk Ravit, Autodesk Showcase, Autodesk Simulation, PTC Creo, PTC ProENGINEER, Solid Edge, SOLIDWORKS.

Texts:

1. Notes of TATA Technologies
2. Curt Larson, " Datum Principles: Flexible Parts: Applications for Automotive Body-in-White and Interior Trim (Dimensional Management Series Book 1)", Right Tech, Inc., Kindle Edition.
3. Curt Larson, " Datum Principles: Flexible Parts: Applications for Automotive Body-in-White and Interior Trim (Dimensional Management Series Book 2)", Right Tech, Inc., Kindle Edition.
4. Vukato Boljanovic, "Sheet Metal Forming Processes and Die Design", Industrial press Inc., Kindle Edition.

References:

1. IbrahimZeid,"CAD/CAM TheoryandPractice", TataMcGrawHillPublication,
2. Mikell P. Grover "Automation, Production Systems and Computer-Integrated Manufacturing", Pearson Education, New Delhi.
3. P. Radhakrishnan & S. Subramanyan "CAD/CAM/CIM" Willey Eastern Limited New Delhi.

4. Onwubiko, C., "Foundation of Computer Aided Design", West Publishing Company. 1989
5. R.W.Heine, C. R.Loper and P.C.Rosenthal, *Principles of Metal Casting*, McGraw Hill, Newyork, 1976.
6. J. H.Dubois And W. I.Pribble, *Plastics Mold Engineering Handbook*, Van NostrandReihnhold, New York, 1987.
7. N. K. Mehta, Machine tool design, Tata Mcgraw-hill, New Delhi, 1989.
8. Geoffrey Boothroyd, Peter Dewhurst and Winston Knight, Product Design for Manufacturing and Assembly, 2nd Edition
9. C. Howard, *Modern Welding Technology*, Prentice Hall, 1979.
10. Grieves, Michael, Product Lifecycle Management, McGraw-Hill, 2006. ISBN 0071452303
11. Stark, John. Product Lifecycle Management: Paradigm for 21st Century Product Realization, SpringerVerlag, 2004. ISBN 1852338105

Automobile Tribology

BTAPE504B	Automobile Tribology	PEC 2	3L-0T-0P	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	Analyze the solid surfaces and their interactions
CO2	Apply lubrication, friction and wear theories in practice.
CO3	Compare liquid and gas lubrication.
CO4	Select appropriate surface treatment to reduce the friction.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit -I:

Introduction to tribology:

Friction, wear and lubrication principles of tribology, thick filmlubrication, and boundary layer lubrication.

Unit -II:

Friction and wear:

Laws of friction, causes of friction, types of wear and mechanisms of wear, wear properties of friction and anti-friction metallic and non-metallic materials.

Unit -III:

Lubricants:

Solid lubricants, liquid lubricants, properties of lubricants, selection for general applications and special applications such as low temperature, high temperature, extreme pressure, corrosion resistance.

Unit -IV:

Hydrodynamic lubrication:

Basic concepts, Reynolds equation, plane bearings, Design of journal bearings- short and finite bearings, design of bearings with steady load, varying load and varying speed.

Unit -V:

Lubrication of automobile systems:

Engine lubricating systems, lubrication of piston, piston rings and cylinder liners, lubrication of cam and followers, lubrication of involutesgears, hypoid gears and worm gears, friction aspects of clutch, brakes and belt drive.

Pneumatic tyres:

Creep and slip of an automobile tyre, functions of tyre, design features of the tyre surface, mechanism of rolling and sliding, tyre performance on wet road surface.

References

1. B. P. Pundir, “Engine Emissions”, Narosa Publications.
2. E. F. Oberts, “Internal Combustion Engine and Air Pollution”, Harper & Row Publisher, NY.
3. J.G. Giles, “Vehicle Operation & Testing” (Automotive Vehicle Technology Vol. 7)
4. C.H. Fisher, “Carburetion”, Vol. 4.
5. A.W. Judge, “Carburetion and Fuel Injection System”, Motor Manual, Vol. 2, The Caxton Pub. Co. Ltd., London.
6. H. H. Willard and Others, “Instrumental Method of Analysis”, CBS Publishers &Distributors, Delhi.

Special Purpose Vehicles

BTAPE504C	Special Purpose Vehicles	PEC 2	3L-0T-0P	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	Classify the different type of special purpose vehicles with its applications.
CO2	Suggest various types of features for given special purpose vehicle.
CO3	Explain the constructional and working features of various special purpose vehicles.
CO4	Apply the fundamental concepts of automotive engineering related to design of special purpose vehicles.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit-I:
Classification and Requirements of Special Purpose Vehicles
Introduction, pre-test, history and overview of an off-road machines, construction layout, capacity and applications, power plants, chassis and transmission, multi-axle vehicles.

Unit-II:
Earth Moving Machines and Tractors
Different types of earth moving equipment's and their applications, Bulldozers, cable and hydraulic dozers, Crawler track, running and steering gears, scrapers, drag and self-powered types - Dump trucks and dumpers - Loaders, single bucket, multi bucket and rotary types - Power and capacity of earth moving machines.
Tractors: General description, Power take off, special implements, specification and functions, light, medium and heavy wheeled tractors, crawler tracks mounted / wheeled-bull dozers, tilt dozers and angle dozers, front end loaders, factors affecting efficiency of output of tractors, simple problems, merits and demerits.

Unit-III:
Scrappers, Graders, Shovels and Ditchers
Scrappers, elevating graders, motor graders, self-powered scrappers and graders, power shovel, revolving and stripper shovels, drag lines, ditchers, capacity of shovels.

Unit IV:
Cranes and Derricks
Types of Cranes Generally used in the Workplace, Components of cranes, Crane and Derricks configuration, Stability against overturning, Analysis of Eight Hazards, Crane safety programs

Unit-V:
Vehicle Systems and Features
Brake system and actuation – OCDB and dry disc calliper brakes. Body hoist and bucket operational hydraulics, Hydro-pneumatic suspension cylinders, Power steering system, Kinematics for loader and bulldozer operational linkages. Safety features, safe warning system for dumper. Design aspects on dumper body, loader bucket and water tank of sprinkler.
Vehicle Evaluation Mobility
Soil-Vehicle Mechanics, characteristics of soils, nominal ground pressure, mean maximum pressure, the mobility index (mi), vehicle cone index (vci) and rated cone index (rci),

mobility number, dynamic behavior and traction on wet soil, traction performance and factors affecting traction performance.

Reference Books:

1. "Construction Equipment and its Management", Sharma, S.C.
2. "Farm Machines and Equipment's", Nakra C.P., Dhanpatrai Publishing company Pvt. Ltd. 2003.
3. "Theory of Ground Vehicles", Wong J Y, John Wiley and Sons, New York, 1978.
4. "Construction Planning and Equipment", Satyanarayana B., Standard publishers and distributors, New Delhi.

Automobile Engineering

BTAPE504D	Automobile Engineering	PEC 2	3L-0T-0P	Audit

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			1	1	2					
CO6	1		2			2						

Course Contents:

Unit 1: Introduction

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

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 4: Wheels and Tyres

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 3: Vehicle Safety Systems

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 5: Electrical Systems

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, Maintenance: trouble shooting and service procedure, over hauling, Engine tune up, Tools and equipment for repair and overhauling, Pollution due to vehicle emissions, Emission control system and regulations.

Texts:

1. KripalSingh, "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	Solar Energy	OEC 1	3L-0T-0P	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											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	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
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
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
Introduction, types of air heater, testing procedure.

Unit 4: Concentrating Collectors
Types of concentrating collectors, performance analysis

Unit 5: Thermal Energy Storage
Introduction, sensible heat storage, latent heat storage and thermo chemical storage
Solar Pond: Solar pond concepts, description, performance analysis, operational problems.
Economic AnalysisDefinitions, annular solar savings, payback period.

Texts:

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 McGraw Hill Publications, 1996.

Renewable Energy Sources

BTMOE505B	Renewable Energy Sources	OEC 1	3L-0T-0P	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

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	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:

Unit1: Introduction

Energyresources,EstimationofenergyreservesinIndia,Currentstatusofenergyconversion technologies relatingtonuclearfissionandfusion,Solarenergy.

Unit2: SolarRadiations

Spectraldistribution,Solar geometry,Attenuationof solar radiationin Earth'satmosphere, Measurementofsolarradiation,Propertiesofopaqueand transparent surfaces.

Unit3: SolarCollectors

FlatPlateSolarCollectors:Construction ofcollector,material,selectioncriteriaforflatplate collectors,testingofcollectors,Limitationofflatplatecollectors,Introduction toETC.

Concentrating typecollectors:Typesofconcentrators,advantages,paraboloid,parabolic trough,Heliostatconcentrator, Selectionofvariousmaterialsusedinconcentrating systems, tracking.

Unit4: SolarEnergyApplications

Air/Waterheating,Spaceheating/cooling,solardrying,andsolarstill,Photo-voltaicconversion.

Unit5: WindEnergyandBiomass

Types ofwindmills,Wind power availability, andwindpower developmentinIndia.Evaluation ofsitesforbio-conversion andbio-mass,Bio-massgasificationwithspecialreferenceto agriculturalwaste.

IntroductiontoOtherRenewableEnergySources

Tidal,Geo-thermal,OTEC;Mini/microhydro-electric,Geo-thermal,Wave, Tidal System design,componentsandeconomics.

Texts:

1. ChetansinghSolanki, "RenewableEnergyTechnologies",PrenticeHallofIndia, 2008.

References:

1. S. P. Sukhatme, "SolarEnergy:PrinciplesofThermalCollectionandStorage", Tata McGrawHill Publications,NewDelhi,1992.
2. G. D.Rai, "SolarEnergyUtilization",KhannaPublisher,Delhi,1992.

Human Resource Management

BTMOE505C	Human Resource Management	OEC 1	3L-0T-0P	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											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	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:

Unit1: IntroductiontoHumanResourceManagement
Conceptofmanagement,conceptofhumanresourcemanagement,personneltohuman resourcemanagement,humanresourcemanagementmodel, importantenvironmental influenceslikegovernmentregulations,policies,laborlawsandotherlegislation.Acquisitionof humanresources:Humanresourceplanning,Demandformanpower,Weaknessesofmanpowerplanning, jobanalysis,jobspecification,recruitmentsources,recruitmentadvertising, theselection process,selectiondevices,equalopportunities:Indianandforeignpractices,socializing thenewemployee

Unit2: DevelopmentofHumanResources
EmployeeTrainingandManagementDevelopment: Training,TrainingandLearning, Identificationoftrainingneeds,trainingmethods,ManagerDevelopment,Methodsfor developingmanagers,evaluatingtrainingeffectiveness
CareerDevelopment: Conceptof career, value of effectivecareerdevelopment, externalversusinternaldimensions toacareer,careerstages,linkingcareerdimensions withstages

Unit3: Motivationof Human Resources
Definitionof motivation, Nature and CharacteristicsofMotivation,Theoriesof motivation:Maslow'sNeedHierarchy Theory,Drucker Theory,LikertTheory, Herzberg TwoFactorTheory, McClellandTheory,McGregor Theory XandY,etc., Psychologicalapproach.
JobDesignandWorkScheduling:
Design,SchedulingandExpectancyTheory,Jobcharacteristicsmodel,jobenrichment, jobrotation,workmodules,flex-time,newtrendsinworkscheduling.

Unit4: PerformanceAppraisal
Performanceappraisalandexpectancytheory;appraisalprocess,appraisalmethods, factorsthat candestroyappraisal.
RewardingtheProductiveEmployee: Rewards and expectancy theory, types of rewards, qualities of effective rewards, criterionsfor rewards.

Unit5: Maintenanceof HumanResources

CompensationAdministration:ConceptofCompensation Administration,Job evaluation,Paystructures,Incentivescompensationplans.
BenefitsandServicesBenefits: Somethingforeverybody,Services,Trendsinbenefits andservices.
Discipline: ConceptofDiscipline,typesofdisciplineproblems,generalguidelines, disciplinaryaction,employment-at-willdoctrine,discipliningspecial employeegroups
SafetyandHealth: safetyprograms,healthprograms,stress,turn out.
LaborRelations
Unions,Majorlaborlegislation,goalsof grouprepresentation.
CollectiveBargaining:
Objectives,scope,participantsofcollectivebargaining,processofcollectivebargaining, trendsin collectivebargaining
Researchandthefuture:Whatisresearch?Typesofresearch,whyresearchinhumanresourcemanagement,Secondarysources:wheretolookitup,Primarysources:relevantresearchmethods, currenttrendsandimplicationsforhumanresourcemanagement.

Texts:

1. David A. DeCenzo,StephenP. Robbins, "Personnel/HumanResources Management",Prentice Hallof IndiaPvt. Ltd,3rd edition,2002.
2. TrevorBolton, "AnIntroductiontoHuman Resource Management", InfinityBooks, 2001.

References:

1. EllenE.Kossek, "HumanResourceManagement TransformingtheWorkplace",InfinityBooks,2001.
2. G.S.Batra, R.C.Dangwal, "HumanResourceManagementNewStrategies", DeepandDeepPublicationsPvt.Ltd.,2001.
3. D.M.Silvera, "HRD: TheIndianExperience",NewIndiaPublications,2nd edition,1990.

Product Design Engineering

BTMOE505D	Product Design Engineering	OEC 1	3L-0T-0P	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:** Knowledge of Basic Sciences, Mathematics and Engineering Drawing
- **Design Studio/Practical:** 2 hrs to develop design sketching and practical skills
- **Continuous Assessment:** Progress through a product design and documentation of steps in the selected product design
- **End Semester Assessment:** Product design in studio with final product specification

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

1. Create simple mechanical designs
2. Create design documents for knowledge sharing
3. Manage own work to meet design requirements
4. Work effectively with colleagues

Course Contents:

Unit 1: Introduction to Engineering Product Design

Trigger for Product/Process/System, Problem solving approach for Product Design, Disassembling existing product(s) and understanding relationship of components with each other, Sketching of components, identifying materials and their processing for final product, fitting of components, understanding manufacturing as scale of the components, Reverse engineering concept, case studies of products in markets, (or in each discipline), underlying principles, Case studies of product failures, Revival of failed products, Public/Society's perception of products, and its input into product design.

Unit 2: Ideation

Generation of ideas, Funneling of ideas, Short-listing of ideas for product(s) as an individual or group of individuals, Sketching of products, Market research for need, competitions, Scale and cost, Initial specifications of products.

Unit 3: Conceptualisation

Designing of components, Drawing of parts and synthesis of a product from its component parts, Rendering the designs for 3-D visualization, Parametric modelling of product, 3-D visualization of mechanical products, Detail engineering drawings of components.

Unit 4: Detailing

Managing assembling, product specifications – data sheet, Simple mechanical designs, Workshop safety and health issues, Create documents for the knowledge sharing.

- **Hands-on Activity Charts for Use of Digital Tools:**

		No. of hrs
Activity 1	Learn the basic vector sketching tools	2
Activity 2	General understanding of shading for adding depth to objects. Understanding of editing vectors	2
Activity 3	Begin developing a thought process for using digital sketching	3
Activity 4	Create a basic shape objects sphere, box cylinders	3
Activity 5	Create automotive wheel concepts	3
Activity 6	Understanding navigation and data panel interface	2
Activity 7	Solid and surface modelling, rendering 3-D models	4
Activity 8	Product market and product specification sheet	3
Activity 9	Documentation for the product	2

Reference:

1. Model Curriculum for "Product Design Engineer – Mechanical", NASSCOM (Ref. ID: SSC/Q4201, Version 1.0, NSQF Level: 7)
2. Eppinger, S., & Ulrich, K.(2015). Product design and development. McGraw-Hill Higher Education.
3. Green, W., & Jordan, P. W. (Eds.).(1999).Human factors in product design: current practice and future trends. CRC Press.
4. Sanders, M. S., & McCormick, E. J. (1993). Human factors in engineering and design. McGRAW-HILLbookcompany.
5. Roozenburg, N. F., &Eekels, J. (1995). Product design: fundamentals and methods (Vol. 2). John Wiley & Sons Inc.
6. Lidwell, W., Holden, K., & Butler, J.(2010). Universal principles of designs,revised and updated: 125 ways to enhance usability, influence perception, increase appeal, make better design decisions, and teach through design. Rockport Pub.

Applied Thermodynamics

BTMC506	PCC11	Applied Thermodynamics	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 the terms like calorific value of fuel, stoichiometric air-fuel ratio, excess air, equivalent evaporation, boiler efficiency, etc. Calculate minimum air required for combustion of fuel.
CO2	Studied and Analyze gas power cycles and vapour power cycles and derive expressions for the performance parameters like thermal efficiency.
CO3	Classify various types of boiler, nozzle, steam turbine and condenser used in steam power plant.
CO4	Classify various typescondenser, nozzle and derived equations for its efficiency.
CO5	Draw P-v diagram for single-stage reciprocating air compressor, with and without clearance volume,and evaluate itsperformance. Differentiate between reciprocating and rotary air compressors.

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										
CO2	1	2										

CO3	1											
CO4			1									
CO5		2										

Course Contents:

Unit 1: Fuels and Combustion **[07 Hours]**

Types of fuels, calorific values of fuel and its determination, combustion equation for hydrocarbon fuel, determination of minimum air required for combustion and excess air supplied conversion of volumetric analysis to mass analysis, fuel gas analysis.

Unit 2: Steam Generators **[07 Hours]**

Classification of boilers, boiler details, requirements of a good boiler; merits and demerits of fire tube and water tube boilers, boiler mountings and accessories.

Boiler Draught: Classification of draught, natural draught, efficiency of the chimney, draught losses, types of boiler draught.

Performance of Boilers: Evaporation, equipment evaporation, boiler efficiency, boiler trial and heat balance, Introduction to IBR.

Unit 3: Vapor and Gas Power Cycles, Steam Nozzles **[07 Hours]**

Ideal Rankine cycle, Reheat and Regeneration, Stirling cycle, Joule-Brayton cycle. Calculation of thermal efficiency, specific steam/fuel consumption, work ratio for above cycles.

Steam Nozzles: Types of Nozzles, flow of steam through nozzles, condition for maximum discharge, expansion of steam considering friction, super saturated flow through nozzles, General relationship between area, velocity and pressure.

Unit 4: Condensers, Cooling Towers and Steam Turbines **[07 Hours]**

Condensers and Cooling Towers: Elements of steam condensing plants, advantages of using condensers, types of condensers, thermodynamic analysis of condensers, efficiencies, cooling towers.

Steam Turbines: Advantages and classification of steam turbines, compounding of steam turbines, velocity diagrams, work one done and efficiencies, losses in turbines.

Unit 5: Reciprocating Air Compressor **[07 Hours]**

Classification constructional details, theoretical and actual indicator diagram, FAD, multi staging, condition for maximum efficiency, capacity control.

Rotary Compressor– ConceptsofRotarycompressors,Root-blowerandvanetype compressors,Centrifugalcompressors.Velocity diagram,constructionandexpressionforwork done, introduction to slip factor, power input factor.

Texts:

1. T. D. Eastop, A. McConkey, “Applied Thermodynamics”, Addison Wesley Longman.
2. Rayner Joel, “Basic engineering Thermodynamics”, Addison Wesley Longman.

References:

1. Yunus A. Cengel, “Thermodynamics- An Engineering Approach", Tata McGraw Hill Publications.
2. P. K. Nag, “Basic and Applied Thermodynamics", Tata McGraw Hill Publications.
3. P. K. Nag, “Power Plant Engineering”, Tata McGraw Hill Publications, 2nd edition.

4. Sharma and Mathur, “Internal Combustion Engines”, Tata McGraw Hill Publications.

Automobile Engineering Lab III

BTACL506	Automobile Engineering Lab III	PCC 11	0L-0T-6P	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 6hrs/week	Continuous Assessment: 60 Marks Mid Semester Exam: -- End Semester Exam: 40 Marks

Machine Design Practice
Listof Practicals/Experiments/Assignments(TWO)

1. Thetermworkshallconsistoftwodesignprojectsbasedonthesyllabusof Machine Design I. Each designproject shallconsist oftwoimperial sizesheets- one involvingassemblydrawingswithapartlistandoveralldimensions andothersheet involvingdrawingsof individualcomponents.Manufacturingtolerances,surfacefinish symbolsandgeometrictolerancesshouldbespecified,wherevernecessary,soastomake itworkingdrawing
2. A designreportgivingallnecessary calculationsforthe designof componentsandassemblyshould be submittedinaseparatefile.

(Manufacturing Processes Lab)ANY FOUR
List of Practicals/ Experiments/ Assignments

Each student shall be required to submit any four jobs from the following:

1. Making a job with a process plan involving plain, step and taper turning as well thread cutting as operations on a Centre lathe.
2. Preparation of process planning sheet for a job including operations such as milling, drilling and shaping.
3. Making a spur gear using universal dividing head on milling machine.
4. Making a simple component by sand casting using a split pattern.
5. Cutting of a steel plate using oxyacetylene flame cutting /plasma cutting.
6. Making a butt joint on two stainless steel plates using TIG/MIG Welding.
7. An experiment on shearing operation.
8. An experiment on blanking operation.
9. An experiment on drawing operation

Automotive Chassis and Suspension Lab
ListofPractical’s/Experiments/Assignments

1. Demonstration of front wheel steering geometry
2. Demonstration of steering system layout

3. Experiment on Ackerman steering geometry
4. Demonstration of power steering
5. Demonstration of hydraulic brake and air brake systems
6. Demonstration of conventional & independent suspensions
7. Demonstration of suspension dampers
8. Demonstration of wheel and tyre assembly
9. Demonstration of garage, garage equipment's & tools, preparation of different garage layouts.
10. Demonstration of washing & greasing of vehicle.

ListofPractical's/Experiments/Assignments (Any 2 Experiment)

1. Engine oil change & periodic maintenance of vehicle.
2. Dismantling & assembly of Clutch (light / heavy duty vehicle).
3. Dismantling & assembly of Constant mesh gearbox and synchromesh gearbox.
4. Dismantling & assembly of Drive line (universal joint, propeller shaft, slip joint).
5. Dismantling & assembly Final drive & differential.
6. Rear axle hub greasing.
7. Dismantling & assembly of automatic transmission.
8. Dismantling & assembly of fluid flywheel & torque converter.

IT – 2 Evaluation

BTAI408 (IT – 2)	IT – 2 Evaluation	PROJ-2	0L-0T-0P	1 Credits

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

SEMESTER VI
Automobile Air Conditioning, Electricals and Electronics

BTAC601	Automobile Air Conditioning, Electricals and Electronics	PCC12	3L-1T-0P	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	Apply design concept to develop refrigeration system for refrigerated vehicle.
CO2	Explain psychometric concepts in design of air-conditioning in vehicle.
CO3	Explain effects of various operating parameters on performance of A/C System.
CO4	Explain troubleshooting methods and maintenance of automotive air conditioning system.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit-I:

Introduction to air conditioning and vapour compression system, cycle diagram (Carnot cycle, Reverse Carnot cycle, Simple vapor compression cycle, bell Coleman cycle), effects of various operating parameters on performance of A/C System, Vapour absorption refrigeration system (No numerical), Applications of air conditioning.

Refrigerants and Air Conditioning Components Environmental concerns/Legislation for automotive A/C systems, types and properties of refrigerants, refrigerant oils, refrigerant piping, Future refrigerants.

Automobile Air conditioning components: Compressors, Condensers, flow control devices, evaporators – Design guidelines, types, sizing and their installation. Accumulators, receiver driers and desiccants. Refrigerant charge capacity determination.

Unit-II:

Psychrometry, Psychometric properties, tables, charts, Psychometric processes, Processes, Combinations and Calculations, ADP, Coil Condition line, Sensible heat factor, Bypass factor,

Load analysis Outside and inside design consideration, Factors forming the load on refrigeration and air conditioning systems, Load calculations for automobiles, Effect of air conditioning load on engine performance, Air conditioning electrical and electronic control, pressure switching devices, sensors and actuators.

Air distribution system Comfort conditions, Air management and heater systems, air distribution modes (Fresh/Recirculation, Face, Foot, Defrost, and Demist), A/C ducts and air

filters, Blower fans, Temperature control systems (manual/semiautomatic, automatic). Vehicle operation modes and Cool-down performance.

Unit III: Introduction to automotive electrical systems

Automotive electricity generation, storage & distribution systems, wiring harness, circuit diagrams and symbols, 12/24/42 voltsystem, positive earth and negative earth, earth return and insulated return systems, Multiplexed wiring systems,Electromagnetic compatibility & interference, Introduction of Controlled Area Networks (CAN) protocols.

Battery:

Principle of lead acid battery, Types, Constructional details, Recharging the battery, Battery ratings, Battery Performance,Battery capacities, Battery efficiency, Battery tests, Battery failures, Alkaline battery, maintenance free batteries, hybrid batteries.

Unit IV:Charging,Starting & Ignition System

Magnetos Constant current & voltage systems, Current & voltage regulator, Semiconductor type regulator, Alternator withregulator, starting system with layout, selection of motor, matching battery, Drive mechanisms, Ignition coil, Distributor, Camangle& Contact angle gap, Advance mechanisms, Ballast Resistance, Limitations of coil ignition, Transistorized Ignitionsystems, Spark plugs, types, construction.

Automotive Accessories & Lighting Systems

Vehicle lighting System: Head, Indicator, Fog lamps, Brake lights, Gas discharge, LED lighting, Dash board Indicators: Fuelgauge, oil pressure gauge, Temperature gauges, Speedometer, Warning Lights, Electric horn, Horn relay, Wind shield wipers, and Power window.

Unit V:Automotive Sensors & Actuators

Working principle of sensors, Types of sensors, Airflow rate sensor, angular position sensor, Throttle angle sensor,Temperature sensor, MAP sensors, sensors feedback control, Principle of actuator, Types of actuators, engine controlactuators, Solenoid actuators, motorized actuators.

Engine Management Control System (EMS)

Layout and working (open loop and closed loop control), ECU and microcontroller, group and sequential injection techniques, fuel system components, cold and warm start system, idle speed control, acceleration / deceleration and full load enrichment and fuel cut-off, fuel control MAPs. Electronic Ignition system and spark timing control.

Vehicle Management System

ABS system with layout and working, Electronic control of suspension – Damping control, Electric power steering, Supplementary Restraint System of air bag system, crash sensor, seat belts, Cruise control, Vehicle security systems alarms, vehicle tracking system, Collision avoidance, Radar warning system, Introduction to Global Positioning Systems.

Text Book:

1. Textbook of “Refrigeration and Air Conditioning” By R. S. Khurmi and J.K.Gupta S. Chand Publication.
2. Steven Daly: “Automotive air conditioning and Climate control systems” Butterworth-Heinemann publications.
3. P. L. Kohli, “Automotive Electrical Equipments”, Tata McGraw Hill Pub. Co. Ltd.
4. Tom Denton, “Automobile Electrical & Electronic Systems”, SAE International.

References:

1. "Principles of Refrigeration"; Roy J Dossat, Pearson Education Inc.
2. "Automotive air conditioning" William H Crouse and Donald L Anglin.
3. "Refrigeration and Air Conditioning", Arora and Damkondwar, Dhanpatrai and Company.
4. "Refrigeration and Air Conditioning", C.P.Arora, Tata McGraw Hills Pub.
5. Steven Daly, "Automotive air conditioning and Climate control systems", Elsevier Ltd, 2011.
6. Boyce H Dwiggins, "Automotive Heating and Air Conditioning", Delmar Thomson Learning Ltd, 2001.
7. Bechfold SAE 1998, "Understanding Automotive Electronics".
8. V. A. W. Hilliers, "Fundamentals of Automotive Electronics", Hatchin, London
9. Tomwather J. R., Cland Hunter, "Automotive Computer & Control System", Prentice Inc. NJ
10. Robert N. Brandy, "Automotive Computers & Digital Instrumentation", Prentice Hall Eaglewood, Cliffs, NJ
11. Young, Griffithe, "Automobile Electrical & Electronic Equipment's", The English Language Book Co., London.

Vehicle Dynamics, Emission and Control

BTAC602	Vehicle Dynamics, Emission and Control	PCC 13	3L-1T-0P	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	Appreciate significance of vehicle dynamics for a typical road vehicle.
CO2	Calculate dynamic longitudinal and transverse axle load transfer for a vehicle in motion.
CO3	Determine the acceleration and braking performance of a vehicle when provided with specifications.
CO4	Evaluate handling characteristics of a vehicle for given set of data.
CO5	Apply ride concepts while designing a suspension system for a vehicle.
CO6	Evaluate the tire performance.

Mapping of course outcomes with program outcomes

course Outcomes	Program Outcomes											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	2	1	1	1	1		1					
CO2	2	2	2		1							
CO3	1	2	2		1							
CO4	2	2	2	1		1	1					
CO5	1	2	2		1							

Course Contents:

Unit I: Performance Characteristics of Road Vehicles

Steady State Operation: Various external forces acting on vehicle,Nature of the forces and factors affecting the forces, Tractive effort &Power available from the engine, Equation of motion, Maximum tractiveeffort, Weight distribution, Stability of vehicle on slope, Roadperformance curves, Acceleration, Gradibility& Drawbar Pull.

Transient Operation: Inertia effect, Equivalent mass, Equivalentmoment of inertia, Equivalent ungeared system, Time to producesynchronizing during gear change, Effect of engine flywheel onacceleration, Dynamics of vehicles on Banked tracks, Gyroscopic Effects,Net driving power.

Unit II:

Handling Characteristics

Low speed cornering, High speed cornering, Cornering equations, Understeer gradient, Static margin, Suspension effects on cornering, Experimental measurements of understeer gradient

Ride Characteristics

Ride dynamic system, Excitation sources, Vehicle suspension properties, Suspension isolation, Suspension stiffness, Suspension damping, Suspension non linearities, Active control, Wheel hop resonances, Rigid body bounce/pitch motions, bounce/pitch frequencies, Olley criterion, dynamic index.

Unit III:

Concept of Vibration

Definitions, Modelling and Simulation, Global and Vehicle Coordinate System, Free, Forced, Undamped and Damped Vibration, Response Analysis of Single DOF, Two DOF, Multi DOF, Magnification factor, Transmissibility, Vibration absorber, Vibration measuring instruments.

Unit-IV:

Introduction

Historical background, Pollutants-sources-formation-effects-transient operational effects on pollution. Historical background, Regulatory test procedures.

SI engine Combustion and Pollutant Formation Chemistry of SI engine Combustion, HC and CO formation in 4 stroke and 2 stroke SI engines, NO formation in SI Engines, Effect of operating variables on emission formation.

CI engine Combustion and Emissions Basic of diesel combustion-Smoke emission in diesel engines-Particulate emission in diesel engines, Colour and aldehyde emissions from diesel engines, Effect of operating variables on emission formation.

Unit-V:

Control Techniques for SI and CI

Design changes, optimization of operating factors, exhaust gas re-circulation, fumigation, air injector PCV system-Exhaust treatment in SI engines-Thermal Reactors-Catalytic converters, Catalysts, Use of unleaded petrol.

Emission Measurement, Test procedures & regulations

Test cycles for light & medium duty vehicles, test procedure for evaporative emissions, Emission standards for light and heavy duty vehicles & motor cycle emission standard. NDIR analyzers, FID, Chemiluminescence, NOx analyzer, oxygen analyzer, smoke measurement, constant volume sampling, and particulate emission measurement

Text Books

1. Gillespie T. D. (1992), Fundamentals of Vehicle Dynamics, SAE International.
2. Wong J. Y. (1979), Theory of Ground Vehicles, Willey & Sons.
3. Springer and Patterson, Engine Emission, Plenum Press, 1990.
4. Ganesan V., “Internal Combustion Engines”, Tata McGraw Hill Co., 1994.

Reference Books

1. Pacejka H. B. (2012), Tyre and Vehicle Dynamics, Butterworth Hienmann
2. N. K. Giri (2004), Automotive Mechanics, Khanna Publishers, 9th Edition.
3. G. Genta (1997), Motor Vehicle Dynamics, World Scientific.
4. Rajamani Rajesh (2011), Vehicle Dynamics and Control, Springer.
5. SAE Transactions, Vehicle emission, 1982 (3 vol).
6. Obert. E. F., “Internal Combustion Engines”, 1982.
7. Taylor C.F., “Internal Combustion Engines”, MIT Press, 1972.
8. Heywood. J.B., “Internal Combustion Engine Fundamentals”, McGraw Hill Book Co., 1995.
9. Automobiles and Pollution SAE Transaction, 1995.
10. B. P. Pundir, Engine Emissions, Narosa Publications.
11. E. F. Oberts, “Internal Combustion Engine and Air Pollution”, Harper & Row Publisher, NY

ELECTIVE III
Vehicle Architecture and Packaging

BTAPE603A	Vehicle Architecture and Packaging	PEC 3	3L-0T-0P	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	
CO2	
CO3	
CO4	

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit I:
Introduction
Brief introduction to CAM – Manufacturing Planning, Manufacturing control- Introduction to CAD/CAM – Concurrent Engineering-CIM concepts – Computerized elements of CIM system –Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance– Simple problems – Manufacturing Control – Simple Problems – Basic Elements of an Automated system – Levels of Automation – Lean Production and Just-In-Time Production.

Unit II:
Planning and Control and Computerized Process Planning
Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control-Inventory Control – Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP) - Simple Problems

Unit III
Cellular Manufacturing
Group Technology(GT), Part Families – Parts Classification and coding – Simple Problems in Opitz Part Coding system – Production flow Analysis – Cellular Manufacturing – Composite part concept – Machine cell design and layout – Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method - Arranging Machines in a GT cell – Hollier Method – Simple Problems.

Unit IV
Guided Vehicle System (Agvs)
Types of Flexibility - FMS – FMS Components – FMS Application & Benefits – FMS Planningand Control– Quantitative analysis in FMS Simple Problems. Automated Guided Vehicle System (AGVS) – AGVS Application Vehicle Guidance technology – Vehicle Management & Safety.

Unit V
Industrial Robotics
Robot Anatomy and Related Attributes – Classification of Robots- Robot Control systems – End Effectors – Sensors in Robotics – Robot Accuracy and Repeatability - Industrial Robot Applications – Robot Part Programming – Robot Accuracy and Repeatability – Simple Problems.

Text Books:
1. Mikell.P.Groover, "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India, 2008.
2. Radhakrishnan P, SubramanyanS.andRaju V., "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi, 2000.

References:
1. Kant Vajpayee S, "Principles of Computer Integrated Manufacturing", Prentice Hall India,2003.
2. Gideon Halevi and Roland Weill, "Principles of Process Planning – A Logical Approach" Chapman & Hall, London, 1995.
3. Rao. P, N Tiwari&T.K. Kundra, "Computer Aided Manufacturing", Tata McGraw Hill, Publishing Company, 2000.

Computer Simulation of IC Engines Processes

BTAPE603B	Computer Simulation of IC Engines Processes	PEC 3	3L-0T-0P	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	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

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

Course Contents:

UNIT-I:

Computer Simulation and Thermodynamics of Combustion

Introduction, Heat of Reaction, Complete Combustion In C/H/O/N Systems, Constant Volume Adiabatic Combustion, Constant Pressure Adiabatic Combustion. Calculation of Adiabatic Flame Temperature.

UNIT-II:

SI Engine Simulation with Fuel-Air as Working Medium

DeviationBetween Actual and Air Standard Cycles of Operation- Problems, SI Engine Simulation with Adiabatic Constant Volume Combustion with Fuel and Air Being Considered, Calculation of Temperature Drop Due to Fuel Vaporization, Calculation of Mean Effective Pressure, Torque and Thermal Efficiency at Full Throttle, Part Throttle and Supercharged Conditions

UNIT-III:

Actual Cycle Simulation in SI Engines

Progressive Combustion; GasExchange Process, Heat Transfer Process, Friction. Procedure of Validating Computer Code with Experimental Data Based on Performance Parameters and Pressure Crank Angle Diagram.

UNIT-IV:

Simulation of 2-Stroke SI Engine Simulation of the Process,Determination of the Pressure-

Crank Angle Variation, Computation of Performance Parameters

UNIT-V:
Diesel Engine Simulation
Main Difference between SI and CI EngineSimulation, Differences Between Ideal and Actual Cycles, Mathematical Combustion Model for Diesel Engine, Heat Transfer and Gas Exchange Processes

REFERENCES:

1. Ganesan, V., "Computer Simulation of Spark Ignition EngineProcess", Universities Press (I) Ltd, Hyderabad, 1996.
2. Ganesan. V., "Computer Simulation of Compression IgnitionEngine Process", Universities Press (I) Ltd, Hyderabad, 2000.
3. AshleyCapbel, "Thermodynamic Analysis of Combustion Engine", John Wiley and Sons, New York - 1986.
4. Benson.R.S., Whitehouse. N.D., "Internal Combustion Engines",Pergamon Press, oxford, 1979.
5. Ramoss.A.L., "Modelling of Internal CombusionEngines Processes", McGraw-Hill Publishing Co., 1992.

Automobile Body Design

BTAPE603C	Automobile Body Design	PEC 3	3L-0T-0P	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: (Pre-requisite: Automobile Design)

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

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

Mapping of course outcomes with program outcomes

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

Course Contents:

Domain Related Training (Approx. 40 hrs)

Unit 1:

BIW : Requirement Specification in the Pre-Program Stage, Product Life Cycle & Important Gateways for BIW, Identification of Commodities for BIW, Design Concept & Considerations in BIW, BIW Materials & Grades, GD & T for BIW.

Unit 2:

Sheet Metal Joining – Welds, Adhesives, TWBs. DFMEA, Design Verification – CAE Methods & Gateway supports Part A & B, CAE Analysis – NVH, Crash & Durability, Test Validation & Assessment.

Unit 3:

Manufacturing – Sequence, Welding & Assembly, Future Trends in BIW, BIW: Examples & Case Studies.

Unit 4:

Trims: Requirement Specification in the Pre-Program Stage, Product Life Cycle & Important Gateways for Trims, Identification of Commodities for Trims, Design Requirements & Considerations, Trim Materials in Automotive.

Unit 5:

Design of Plastic Part, DFMEA, Design Verification – CAE Methods & Gateway supports, CAE Analysis – Moldflow, Crash & Durability, Test Validation & Assessment.

Manufacturing Process, Assembly Sequence, Future Trends & Future Material for Trims,

Trims: Examples & Case Studies.

Texts:

1. Notes of TATA Technologies
2. Curt Larson, " Datum Principles: Flexible Parts: Applications for Automotive Body-in-White and Interior Trim (Dimensional Management Series Book 1)", Right Tech, Inc., Kindle Edition.
3. Curt Larson, " Datum Principles: Flexible Parts: Applications for Automotive Body-in-White and Interior Trim (Dimensional Management Series Book 2)", Right Tech, Inc., Kindle Edition.

References:

1. Vukato Boljanovic, "Sheet Metal Forming Processes and Die Design", Industrial press Inc., Kindle Edition.
2. R. D. Cook, Concepts and Applications of Finite Element Analysis; John Wiley and Sons, second edition, 1981.
3. K.J. Bathe, Finite Element Method and Procedures; Prentice hall, 1996.
4. IbrahimZeid,"CAD/CAM Theory and Practice", Tata McGraw Hill Publication,
5. J. H.Dubois And W. I.Pribble, *Plastics Mold Engineering Handbook*, Van NostrandReihnhold, New York, 1987.
6. Geoffrey Boothroyd, Peter Dewhurst and Winston Knight, Product Design for Manufacturing and Assembly, 2nd Edition
7. C. Howard, *Modern Welding Technology*, Prentice Hall, 1979.
8. Jesper Christensen and Christophe Bastien, "Nonlinear Optimization of Vehicle Safety Structures: Modeling of Structures Subjected to Large Deformations, Butterworth-Heinemann, Kindle Edition
9. Grieves, Michael, Product Lifecycle Management, McGraw-Hill, 2006. ISBN 0071452303
10. Stark, John. Product Lifecycle Management: Paradigm for 21st Century Product Realization, SpringerVerlag, 2004. ISBN 1852338105

Vehicle Aerodynamics

BTAPE603D	Vehicle Aerodynamics	PEC 3	3L-0T-0P	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	Apply basic principles of aerodynamics for the design of vehicle body.
CO2	Calculate lift and drag of automotive models
CO3	Describe the physics of fluid flow over vehicle body and its optimization techniques.
CO4	Use wind tunnels for testing the vehicles.
CO5	Suggest noise measurement and control techniques of a vehicle.

Mapping of course outcomes with program outcomes

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

Course Contents:

UNIT- I: Introduction
Scope, historical developments, fundamental of fluid mechanics, flow phenomenon related to vehicles, external and internal flow problem, resistance to vehicle motion, performance, fuel consumption and performance potential of vehicle aerodynamics.

UNIT -II: Aerodynamic Drag of Cars
Cars as a bluff body, flow field around car, drag force, types of drag force, analysis of aerodynamic
drag, drag coefficient of cars, strategies for aerodynamic development, low drag profiles.

UNIT-III: Shape Optimization of Cars
Front end modification, front and rear wind shield angle, boat tailing, hatch back, fast back and square back, dust flow patterns at the rear, effects of gap configuration, effect of fasteners. Case studies on modern vehicles.

UNIT- IV: Vehicle Handling
The origin of forces and moments on a vehicle, lateral stability problems, methods to calculate forces
and moments – vehicle dynamics under side winds, the effects of forces and moments, characteristics
of forces and moments, dirt accumulation on the vehicle, wind noise, drag reduction in commercial
vehicles and racing cars.

UNIT -V: Wind Tunnels for Automotive Aerodynamics
Introduction, principle of wind tunnel technology, limitation of simulation, stress with scale models, full scale wind tunnels, measurement techniques
Wind
Wind noise, measurement techniques, Control techniques. Road testing methods, numerical methods.

Text Books:

1. Hucho W.H., "Aerodynamic of Road Vehicles", Butterworths Co., Ltd., 1997

References:

1. Pope, "Wind Tunnel Testing", 2nd Edition, John Wiley & Sons New York, 1974.
2. "Automotive Aerodynamic", Update SP-706, Society of Automotive Engineers Inc, 1987
3. "Vehicle Aerodynamics", SP-1145, Society of Automotive Engineers Inc, 199

E Vehicles

BTAPE603E	E Vehicles	PEC 3	3L-0T-0P	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	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit I:

Introduction to EV:

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 II:

EV System:

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

EV Parameters:

Weight, size, force, energy & performance parameters.

Unit III:

EV Propulsion:

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:
DC Motor: Type of wound-field DC Motor, Torque speed characteristics
DC-DC Converter, Two quadrant DC Chopper, 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:
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 Press Inc., 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.

Design of Experiments

BTAPE603F	Design of Experiments	PEC 3	3L-0T-0P	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

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

CO1	Define Taguchi, factorial experiments, variability, orthogonal array, quality loss.
CO2	Plan and design the experimental investigations efficiently and effectively.
CO3	Understand strategy in planning and conducting experiments.
CO4	Evaluate variability in the experimental data using ANOVA.
CO5	Practice statistical software to achieve robust design of experiments.

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	1
CO2	3	2	1	3	2	1			1	2	1	1
CO3	3	2	1	3	2	1			1	2	1	1
CO4	3	3	1	3	2	1			1	2	1	1
CO5	2	3	1	2	3	2			1	2	1	1

Course Contents:

Unit 1: Introduction
Modern quality control, quality in engineering design, history of quality engineering, The Taguchi Approach to quality: Definition of quality, loss function, offline and online quality control, Taguchi`s quality philosophy.

Unit 2: Full Factorial Designs
traditional scientific experiments, two factor design, three factor design, replicating experiments, factoring reactions, normal plots of estimated effects, mechanical plating experiments, four factor design, Taguchi design and western design.

Unit 3: Fractional Factorial Design
Fractional factorial design base done ightrunexperiments, folding over an eight run experimental design, Fractional factorial design in sixteen run, folding over sixteen run experimental design, blocking two level designs, other two level designs, Necessity to use more than two level, factors at three and four levels.

Unit 4: Taguchi Robust Design
Construction of orthogonal array, Additive model for factor effects, Signal to noise ratios, linear graphs, Taguchi Inner and outer arrays: Noise factors, experimental designs for control and noise factors.

Unit 5: Evaluating Variability

Necessity to analyze variability, measures of variability, the normal distribution, Analysis of variance in engineering design, using estimated effects as test statistics, analysis of variance for two level designs

Computer Software for Experimental Design

Role of computer software in experimental design, summery of statistical packages, example of use of software packages.

Texts:

1. M. S. Phadke, "Quality Engineering using Robust Design", Prentice Hall, Englewood Cliffs, NewJersey,1989.
2. R.H. Lochnerand J.E. Matar, "Designing for Quality: An Introduction to the Best of Taguchi and Western Methods of Statistical Experimental Design", Chapmanand Hall, London, 1983.

References:

1. D.C. Montgomery, "Design and Analysis of Experiments", John Wiley and Sons, New York, 5th edition, 2004.
2. Peter Goos, Bradley Jones, "Optimal Design of Experiments: A Case Study Approach", Wiley Publishers, July 2011.
3. Raymond H. Myers, Douglas C. Montgomery, Christine M. Anderson-Cook, "Response Surface Methodology: Process and Product Optimization Using Designed Experiments", 4th Edition, Wiley, January 2016.

Elective IV
Transport Management

BTAPE604A	Transport Management	PEC 4	3L-0T-0P	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3hrs/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	Describe the motor vehicle act & central motor vehicle rules.
CO2	Illustrate motor vehicle insurance & taxation.
CO3	Analyze the passenger & goods transport operations.
CO4	Identify advanced techniques in traffic management.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit I:
Motor Vehicle Act Short titles & definitions, Laws governing to use of motor vehicle & vehicle transport, Licensing of drivers & conductors, Registration of vehicle, State & interstate permits, Traffic rules, Signals & controls, Accidents, Causes & analysis, Liabilities & preventive measures, Rules & regulations, Responsibility of driver, Public & public authorities, Offences, penalties & procedures, Different types of forms, Government administration structure, Personnel, Authorities & duties, Rules regarding construction of motor vehicles.

Unit II:
Taxation Objectives, Structure & methods of laving taxation, Onetime tax, Tax exemption & tax renewal

Unit III:
Insurance types & significance, Comprehensive, Third party insurance, Furnishing of particulars of vehicles involved in accident, MACT (Motor Accident Claims Tribunal), Solatium Fund, Hit & Run case, Duty of driver in case of accident, Surveyor & Loss Assessor, Surveyors report

Unit IV:
Passenger Transport Operation Structure of passenger transport organizations, Typical depot layouts, Requirements and Problems on fleet management, Fleet maintenance, Planning - Scheduling operation & control, Personal & training-training for drivers & conductors, Public

relations, Propaganda, publicity and passenger amenities, Parcel traffic., Theory of fares-Basic principles of fare charging, Differential rates for different types of services, Depreciation & debt charges, Operation cost and Revenues, Economics & records.

Unit V:
Goods Transport Operation Structure of goods transport organizations, Scheduling of goods transport, Management Information System (MIS) in passenger / goods transport operation, Storage & transportation of petroleum products.
Advance Techniques in Traffic Management Traffic navigation, Global positioning system

References Books:

1. Motor Vehicle Act - Govt. of India Publications.
2. S.K. Shrivastava, "Economics of Transport"
3. "Transport Development in India", S. Chand & Co. Pvt. Ltd., New Delhi.
4. Santosh Sharma, "Productivity in Road Transport", 2nd Edition, Association of State Road Transport Undertakings, New Delhi.
5. P.G.Patankar, "Road Passenger Transport in India", CIRT, Pune

Computational Fluid Dynamics

BTAPE604B	Computational Fluid Dynamics	PEC 4	3L-0T-0P	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 applications of finite volume and finite element methods to solve Navier-Stoke equations.
CO2	Evaluate solution of aerodynamic flows. Appraise & compare current CFD software. Simplify flow problems and solve them exactly.
CO3	Design and setup flow problem properly within CFD context, performing solid modeling using CAD package and producing grids via meshing tool
CO4	Interpret both flow physics and mathematical properties of governing Navier-Stokes equation and define proper boundary conditions for solution.
CO5	Use CFD software to model relevant engineering flow problems. Analyse the CFD results Compare with available data, and discuss the findings

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit-I: Introduction to CFD

CFD – a research and design tool, CFD as third dimension of engineering supplementing theory and experiment, Steps in CFD solution procedure, strengths and weakness of CFD, Flow modeling using control volume - finite and infinitesimal control volumes, Concept of substantial derivative, divergence of velocity, Basic governing equations in integral and differential forms – conservation of mass, momentum and energy (No derivations), Physical interpretation of governing equations, Navier-Stoke's model and Euler's model of equations.

Unit- II: Basic Discretization Techniques

Introduction to grid generation (Types of grids such as structured, unstructured, hybrid, multi-block, Cartesian, body fitted and polyhedral etc.), Need to discretize the domain and governing equations, Finite difference approximation using Taylor series, for first order (Forward Difference Approximation, Backward Difference Approximation, Central difference Approximation) and second order (based on 3 node, 4 node and 5 node points),explicit and Implicit approaches applied to 1D transient conduction equation, Couetteflow equation () using FTCS and Crank Nicholson's Method, Stability Criteria concept and physical interpretation, Thomas Tri-diagonal matrix solver.

Unit-III: Two Dimensional Steady and unsteady heat conduction
Solution of two dimensional steady and unsteady heat conduction equation with Dirichlet, Neumann, Robbins and mixed boundary condition – solution by Explicit and Alternating Direction Implicit method (ADI Method), Approach for irregular boundary for 2D heat conduction problems.

Unit-IV: Application of Numerical Methods to Convection – Diffusion system
Convection: first order wave equation solution with upwind, Lax–Wendroff, Mac Cormack scheme, Stability Criteria concept and physical interpretation **Convection –Diffusion:** 1D and 2D steady Convection Diffusion system – Central difference approach, Peclet Number, stability criteria, upwind difference approach, 1 D transient convection-diffusion system

Unit-V: Incompressible fluid flow
Solution of Navier-Stoke's equation for incompressible flow using SIMPLE algorithms and its variation (SIMPLER), Application to flow through pipe, Introduction to finite volume method.
CFD as Practical approach
Introduction to any CFD tool, steps in pre-processing, geometry creation, mesh generation, selection of physics and material properties, specifying boundary condition, Physical Boundary condition types such as no slip, free slip, rotating wall, symmetry and periodic, wall roughness, initializing and solution control for the solver, Residuals, analyzing the plots of various parameters (Scalar and Vector contours such as streamlines, velocity vector plots and animation). Introduction to turbulence models.Reynolds Averaged Navier-Stokes equations (RANS), k-ϵ, k-. Simple problems like flow inside a 2-D square lid driven cavity flow through the nozzle

Texts/References:

1. "Computational Fluid Dynamics", John D Anderson: The Basics with Applications, McGraw-Hill
2. "Computational Fluid Dynamics", J. Tu, G.-H. Yeoh and C. Liu: A practical approach, Elsevier.
3. "Introduction to Computational Fluid Dynamics", A. W. Date: Cambridge University Press
4. "Computer Simulation of Fluid flow and heat transfer", P.S.Ghoshdastidar: Tata McGraw-Hill.
5. "Numerical Simulation of internal and external flows", Vol. 1, C. Hirsch, Wiley
6. Computational Fluid Mechanics and Heat transfer, Tannehill, Anderson, and Pletcher, CRC Press.

Ergonomics in Automotive Design

BTAPE604C	Ergonomics in Automotive Design	PEC 4	3L-0T-0P	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	Use an anthropometrics and its application to vehicle ergonomics
CO2	Apply design concepts to develop driver seats for commercial vehicle.
CO3	Apply design concepts to develop driver seats for luxury vehicle.
CO4	Explain significance of visibility with blind region concepts.
CO5	Suggest interior design features to enhance comfort level of the vehicle passenger.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit- I:
Introduction to human body, Anthropometrics and its application to vehicle ergonomics.

Unit-II:
Driver comfort – seat types, visibility, man-machine system, Psychological factors – stress, attention, driver seat design, cockpit / driver worth station design.

Unit-III:
Passenger comfort - Ingress and egress, spaciousness, ventilation, temperature control, dust and fume prevention and vibration.

Unit -IV:
Introduction to filed view, types of filed view, forward field of view and evaluation, mirror design issue, methods of measuring field of view, and other visibility issues

Unit-V:
Interior features and conveniences (legroom, gang way, types of seat, head room, visibility, window rattling)—Use of modern technology for the same.
Safety issues, Ergonomic research methods / ergonomic audit

Texts/References:

1. Nikolao sGkikas, *"Automotive ergonomics Driver vehicle interaction"* CRC Press Publication, 2013
2. Mark R Lehto, James R Buck, *"Introduction to human factors and ergonomics for engineers",*Taylor and Francis Group publication, 2008.
3. Vivek D Bhise, *"Ergonomics in automotive design process"*, CRC Press Publications, 2012.
4. B. Peacock,Waldemar Karwowski, *"Automotive Ergonomics",* Taylor & Francis Publication, 1993.
5. David Meister, *"The History of Human Factors and Ergonomics",* Taylor & Francis Publication, 1999.

Tractor and Farm Equipment

BTAPE604D	Tractor and Farm Equipment	PEC 4	3L-0T-0P	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	Apply the fundamental design concepts for design of tractor and farm equipments.
CO2	Describe the important supplementary systems in the tractors.
CO3	Select the different system for particular type of farm application.
CO4	Compare the performance of tractors related to various attachments.
CO5	Describe different engine systems of a farm tractor.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit-I:
General Design of Tractors:
Classification of tractors, Main components of tractor, Safety rules.

Unit-II:
Fundamentals of Engine Operation:
Tractor controls and the starting of the tractor engines-Basic notations and definition-Engine cycles–Operation of multi-cylinder engines-General engine design–Basic engine performance characteristics.

Unit-III:
Engine Mechanism of Tractor:
Cylinder and pistons, Connecting rods and crankshafts - Engine balancing – Construction and operation of the valve mechanism - Valve mechanism components -Valve mechanism troubles.

Unit-IV:
Cooling System, Lubrication System and Fuel System of a Tractor Engine
Cooling system -Classification -Liquid cooling system -Components, Lubricating system servicing and troubles - Air cleaner and turbo charger - Fuel tanks and filters –Fuel pumps.

Unit-V:

Farm Tractor Transmission System:

Layout, Load distribution, Transmission & Drive line, Steering, Braking system, Wheels & Tyres, Hydraulic system, Auxiliary Systems, Draw bar.

Farm Equipment's:

Working attachments of tractors - Farm equipment - Classification – Auxiliary equipment - Trailers and body tipping mechanism.

Texts/References:

1. E. L. barger, J. B. Liljedahl, W. M. Carleton, E. G. Mckibben "Tractors & their power units".
2. Rodichev and G. Rodicheva, "Tractor and Automobiles ", MIR Publishers, 1987.
3. Kolchin. A., and V. Demidov, "Design of Automotive engines for tractor", MIR Publishers,1972.

Noise and Vibration

BTAPE604E	Noise and Vibration	PEC 4	3L-0T-0P	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 basic concepts related to noise and vibration.
CO2	Formulate mathematical model for multi degree of freedom vibration system.
CO3	Select transducers for measurement of vibration in automotive systems
CO4	Select appropriate transducer for measurement of noise in automotive systems.
CO5	Identify different sources and apply methods for noise and vibration control in automobiles

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit-I:
Multi Degree of Freedom Vibrations:
Matrix formulation, eigen values and eigen formulation, matrix iteration techniques -normal modes and orthgonality, transient response of multi degree freedom system, mode superposition technique, torsional oscillations of multi-rotor systems.

Unit-II:
Torsional vibrations:
Simple systems with one or two rotor masses Multi-DOF systems-transfer matrix method Geared system Branched system

Unit-III:
Vibration Instrumentation:
Vibration measurements – Vibration measurement parameters (displacement, velocity & acceleration), instrumentation –electrodynamics exciters – impact hammers, piezoelectric accelerometers, signal conditioning and amplification, filters, preamplifiers and power amplifiers, real time analysis, FFT analysis, structural frequency response measurement, modal testing of beams, Modal parameter (natural frequency, mode shape and damping)estimation techniques

Unit-IV:
Vibration analysis:
Relevance of vibration analysis, introduction to experimental modal analysis**,** Structural

Modal analysis, mode shapes, Euler's beam equation for natural frequency, Calculation of natural frequencies - Rayleigh method, Stodala method, machine diagnostics through vibration analysis.

Unit-V:
Noise:
Introduction, causes, effects, basic terms, Noise characteristics, Sources of noise, vehicular noise level, engine noise, transmission noise, brake squeal, structural noise, noise in auxiliaries, wind noises, wave equation, noise standards etc.

Unit-VI:
Noise measurement:
Sound and Noise parameters, propagation of sound & noise in various machinery's, noise measuring parameters, noise level measurement techniques, Noise level interpolation andmapping, noise measuring instruments
Noise Control:
Mechanization of noise generation, noise control methodologies, noise control measures, environmental noise management, Road vehicle noise standards, Sound absorption by porous materials, silencer and suppression systems, Sound absorption, sound insulation, acceptance noise levels

Text Books:

1. N. L. Meirovitch, "Elements of vibration Analysis", McGraw Hill New York, 1986.
2. J.P. Den Hartog, "Mechanical Vibration, 4th edition", McGraw Hill, New York 1985.
3. "Industrial Noise & Vibration Control", Irwin &Garf.
4. "Mechanical Vibration", S. S. Rao, New Age International (P) Ltd., New Delhi.
5. "Mechanical Vibration Analysis", P. Srinivasan, Tata McGraw Hill Pub. New Delhi.
6. "Mechanical Vibration", Grover G. K., Nem Chand & Brothers, Roorkee.
7. "Engineering Vibration", Daniel J. Inman, Prentice Hall, NJ.
8. "Theory of Vibrations", W. T. Thomson, CBS Publishers, New Delhi.
9. "Noise, Pollution & Control", S. P. Singal, Narosa Publishing House, New Delhi.
10. "A text book of sound", L.P. Sharma & H.C. Saxena.
11. "Engineering Noise Control", D.A. Bies& C.H. Hausen.
12. "Noise & Vibration Control", Leo N. Beraneck.

Reference Books:

1. Harris, C. M. Handbook of Acoustical Measurements and Noise Control, Acoustical Society of America, 1998.
2. Beranek L. L. &Ver I. L., Noise and Vibration Control Engineering: Principles and Applications, 2nd ed., Wiley 2006
3. Leonard Meirovitch, Fundamentals of Vibrations, McGraw Hill New York.
4. J.S. Rao and K. Gupta, "Advanced Theory of Vibration",Willey Eastern.1992.
5. R.A. Collacott, "Vibration Monitoring and diagnosis", John Willey, New York, 1979.
6. M. Petyt, "Introduction to Finite Element Vibration Analysis", Cambridge University
7. "Fundamentals of Mechanical Vibration", S. Graham Kelly, Tata McGraw Hill.

Product Life Cycle Management

BTMPE604B	Product Life Cycle Management	PEC 4	3L-0T-0P	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 need and advantages of PLM
CO2	Describe the various PLM strategies
CO3	Describe the various steps in design and development of product
CO4	Understand the technology forecasting
CO5	Describe the importance of innovation in product design and development
CO6	Apply PLM to at least one 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												
CO2												
CO3												
CO4												
CO5												
CO6												

Course Contents:

Unit 1: Introduction and Strategies to PLM
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)
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
Engineering design, organization and decomposition in product design, product design process, methodical evolution in product design, concurrent engineering, design for 'X' and design central 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
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

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

Texts/References:

1. Grieves, Michael, "Product Lifecycle Management", Tata McGraw-Hill, 2006, ISBN 007145230330.
2. AnttiSaaksvuori, AnselmiImmonen, "Product Life Cycle Management", Springer, 1st edition, 2003.
3. Stark, John, "Product Lifecycle Management: Paradigm for 21st Century 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	Finite Element Method	PEC 4	3L-0T-0P	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 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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2			1								
CO2	1	2	2	2								
CO3	1	3		1	1							
CO4	1	2			1							
CO5	1	2	1	1	2							
CO6	2	2										

Course Contents

Unit I: Introduction
Finite element analysis and its need; Advantages and limitations of finite element analysis (FEA); FEA procedure.

Unit II: Elements of Elasticity
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 III:Relevant Matrix Algebra
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 IV: One-dimensional Problems
Introduction; FE modeling; Bar element; Shape functions; Potential energy approach; Global stiffness matrix; Boundary conditions and their treatments; Examples.

Unit V: Trusses and Frames
Introduction; Plane trusses; Element stiffness matrix; Stress calculations; Plane frames; examples.
Two-dimensional Problems
Introduction and scope of 2-D FEA; FE modelling of 2-D problem; Constant strain triangle; Other finite elements (no mathematical treatment included); Boundary conditions.

Texts:

1. 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. 2.P. Seshu, ―A Textbook of Finite Element Analysis‖, Prentice Hall of India Pvt. Ltd., New Delhi, 2003.
3. 3.R. D. Cook, D. S. Malkus, M. E. Plesha, R. J. Witt, ―Concepts and Applications of Finite
    1. Element Analysis‖, John Wiley & Sons, Inc.

References:

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

Robotics

BTMPE604D	Robotics	PEC 4	3L-0T-0P	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	List the various components of a typical Robot, grippers, sensors, drive system and describe their functions
CO2	Calculate the word to joint and joint to word coordinates using forward and reverse transformations
CO3	Calculate the gripper forces, drive sizes, etc.
CO4	Develop simple robot program for tasks such as pick and place, arc welding, etc. using some robotic language such as VAL-II, AL, AML, RAIL, RPL, VAL
CO5	Evaluate the application of robots in applications such as Material Handling, process operations and Assembly and inspection
CO6	Discuss the implementation issues and social aspects of robotics

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Introduction
Variousbasic componentsofaRoboticsystem,variousconfigurations,workenvelopes, Manipulators,sensors,controllers,etc.

Unit2: MechanicalSystemin Robotics
Motion conversion,Kinematic chains, position analysis,forwardandbackward transformations,naturalandjointspacecoordinates.

Unit3: DrivesforRobot
Electricaldrives**,**Steppermotor,DCmotors,ACmotors,hydraulicandpneumaticdrives, hybriddrives,driveselectionforroboticsjoints.

Unit4: Sensorsin Robotics
Positionsensor,velocitysensor,proximitysensors,touchsensors,forcesensors,etc.

Unit5: RobotProgramming
Pathplanning,Leadthrough(manualandpowered)programming,teachpendantmode, programminglanguages,AL,AML,RAIL,RPL,VALpmentin robotics
ArtificialIntelligenceforRobots:
KnowledgeRepresentation,Problemrepresentationandproblemsolving,search techniquesinproblemsolving
RobotApplications
Applicationofrobotin:Materialhandling,assemblyandinspection,processoperations, etc.

Texts:

1. M. P. Grover, “Industrial Robotics: Technology, Programming and Applications”, Tata McGraw Hill Publication.

References:

1. Saeed B. Niku, “Introduction to Robotics, Analysis, Systems, Applications”, Pearson Education.
2. Richard D. Klafter, “Robotic Engineering: An Integrated Approach”, Prentice Hall of India.

Open Elective-II

Quantitative Techniques in Project Management

BTMOE605A	Quantitative Techniques in Project Management	OEC 2	3L-1T-0P	4Credits

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: 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											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	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
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
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
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
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
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.

Texts:

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

Nanotechnology

BTMOE605B	Nanotechnology	OEC 2	3L-1T-0P	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: None

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

CO1	Demonstrate the understanding of length scales concepts, nanostructures and nanotechnology.
CO2	To impart basic knowledge on various synthesis and characterization techniques involved in Nanotechnology
CO3	To educate students about the interactions at molecular scale
CO4	Evaluate and analyze the mechanical properties of bulk nanostructured metals and alloys, Nano-composites and carbon nanotubes.
CO5	To make the students understand about the effects of using nanoparticles over conventional methods

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	1	1		3	3	2	1		3		1	3
CO2	3	2			3	3	2				1	3
CO3	1	1	1	3	2				2	1		1
CO4	1	1		3	3	2	1		3		1	3
CO5	1	1	1	3	2				2	1		1

Course Contents:

Unit 1: Scientific Revolutions
Types of Nanotechnology and Nano machines: the Hybrid nanomaterial. Multiscale hierarchical structures built out of Nano sized building blocks (nano to macro).Nanomaterials in Nature: Nacre, Gecko, Teeth. Periodic table, Atomic Structure, Molecules and phases, Energy, Molecular and atomic size, Surfaces and dimensional space: top down and bottom up.

Unit 2: Forces between Atoms and Molecules
Particles and grain boundaries, strong Intermolecular forces, Electrostatic and Vander Waals forces between surfaces, similarities and differences between intermolecular and inter particle forces covalent and coulomb interactions, interaction polar molecules.
Thermodynamics of self-assembly.

Unit 3: Opportunity at the Nano Scale
Length and time scale in structures, energy landscapes, Inter dynamic aspects of inter

molecular forces, Evolution of band structure and Fermi surface.

Unit 4: Nano Shapes
Quantum dots, Nano wires, Nano tubes, 2D and 3D films, Nano and mesopores, micelles, bilayer, vesicles, bionano machines, biological membranes.

Unit 5: Influence of NanoStructuring
Influence of Nano structuring on mechanical, optical, electronic, magnetic and chemical properties-gram size effects on strength of metals- optical properties of quantum dots.
Nano Behaviour
Quantum wires, electronic transport in quantum wires and carbon nano-tubes, magnetic behavior of single domain particles and nanostructures, surface chemistry of Tailored monolayer, self-assembling.

Texts:

1. C. Koch, "Nanostructured materials: Processing, Properties and Potential Applications", Noyes Publications, 2002.
2. C. Koch, I. A. Ovidko, S. Seal and S. Veprek, "Structural Nano crystalline Materials: Fundamentals & Applications", Cambridge University Press, 2011.

References:

1. Bharat Bhushan, "Springer Handbook of Nanotechnology", Springer, 2nd edition, 2006.
2. Laurier L. Schramm, "Nano and Microtechnology from A-Z: From Nano-systems to Colloids and Interfaces", Wiley, 2014.

Energy Conservation and Management

BTMOE605C	Energy Conservation and Management	OEC 2	3L-1T-0P	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: 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	Analyze 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											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
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:

Unit1: Introduction
Generalenergyproblem,Energyusepatternsandscopeofconservation.
EnergyManagementPrinciples:Need,Organizing,Initiatingandmanaginganenergy managementprogram.

Unit2: Energy Auditing Elementsandconcepts,Typesofenergyaudits,Instrumentsusedin energyauditing.
EconomicAnalysis:Cashflows,Timevalueofmoney,Formulaerelatingpresentand futurecashflows-single amount,uniformseries.

Unit3: FinancialAppraisalMethods
Paybackperiod,Netpresentvalue,Benefit-costratio, Internal-rateof return,Lifecyclecosts/benefits.Thermodynamicsofenergyconservation,EnergyconservationinB oilersandfurnaces, EnergyconservationinSteamandcondensatesystem.

Unit4: Cogeneration
Concept,Typesofcogenerationsystems, performanceevaluationofa cogenerationsystem.
WasteHeatRecovery:Potential,benefits,wasteheat recoveryequipment's.
SpaceHeating,VentilationAirConditioning (HVAC)andwaterheatingofbuilding, Transferofheat,Spaceheatingmethods, Ventilationandairconditioning, Heatpumps, Insulation,Cooling load,Electricwaterheatingsystems,Electricenergyconservation methods.

Unit5: Insulation and Heating
IndustrialInsulation:Insulationmaterials,Insulationselection,Economicalthicknessof insulation. IndustrialHeating:Heatingbyindirectresistance,directresistanceheating(saltbath furnace),and Heattreatmentbyinductionheatingintheelectricarcfurnaceindustry.
EnergyConservationinElectricUtilityandIndustry
Energycostsandtwopart tariff,Energyconservationinutilitybyimprovingloadfactor,Loadcurveanalysis, Energy efficientmotors,Energy conservationinilluminationsystems,Importanceof Powerfactorinenergyconservation,Powerfactorimprovement methods,Energy conservationinindustries

Texts:

1. Callaghan,"EnergyConservation".
2. D.L.Reeg,"IndustrialEnergyConservation",PergamonPress.

References:

1. T.L.Boyen,"ThermalEnergyRecovery",WileyEastern.
2. L.J.Nagrath,"SystemModelingandAnalysis",TataMcGrawHill Publications.
3. S.P.Sukhatme,"SolarEnergy",TataMcGrawHill Publications.

Wind Energy

BTMOE605D	Wind Energy	OEC 2	3L-1T-0P	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: 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											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
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
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

Unit 2: Wind Measurements
Biological indicators, Rotational anemometers, other anemometers, Wind direction

Unit 3: Wind Turbine Power, Energy and Torque
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 4: Wind Turbine Connected to the Electrical Network
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 5: Wind Turbines with Asynchronous Electric Generators
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.
Economics of Wind Systems
Capital costs, Economic concepts, Revenues requirements, Value of wind generated electricity

Texts:

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.

Introduction to Probability Theory and Statistics

BTMOE605D	Introduction to Probability Theory and Statistics	OEC 2	3L-1T-0P	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: None

Course Objective

The objective of this course is

(i)To Acquire the knowledge of mean, median, mode, dispersion, etc.
(ii) To develop the basics of Probability theory
(iii) To get the knowledge of random variables and their expectations
(iv) To establish acquaintance with various probability distributions
(v) To Acquire the knowledge of correlation and regression.

Course Outcome

At the end of the course, the student will be able to

(i) Apply the concepts tofind the measure of the central tendency, dispersion and moments for grouped data
(ii) Make use of the correlation, and regression analyses to find the correlation and regression coefficients
(iii) Observe and analyze the behavior of various discreteand continuous probability distributions
(iv) Investigate the properties such as mathematical expectation and variance of the random variables.

Course Contents:

Unit I: Probability

Probability Theory: Definition of probability, Addition theorem of probability, Multiplication theorem of probability, Conditional probability, Bayes' theorem of inverse probability, Properties of probabilities with proofs.
[08 Hours]

Unit II: Theoretical Probability Distributions

Theoretical Probability Distributions: Binomial distribution, Poisson distribution, Normal distribution, Fitting of binomial distributions, Properties of Binomial, Poisson and normal distributions, Relation between binomial and normal distributions, Relation between Poisson and normal distributions, Importance of normal distribution, Examples. **[08 Hours]**

Unit III: Moments, Skewness and Kurtosis

Moments about mean and an arbitrary point; Skewness: positive skewness, negative skewness, symmetric frequency distribution, Bowley's coefficient of skewness, Karl Pearson's coefficient of skewness,

Measures of skewness based on moments (β_1, γ_1); Concepts of kurtosis, leptokurtic, mesokurtic and platykurtic frequency distributions.
[08 Hours]

Unit IV: Correlation and Regression
Correlation: Types of correlation, Karl Pearson's correlation coefficient (Covariance Method), Spearman's rank correlation method, Regression: lines of regression, fitting of lines of regression by the least squares method, interpretation of slope and intercept, properties of regression coefficients.
[08 Hours]

Unit V: Sampling Theory and Testing of Hypothesis

Introduction to sampling distributions, Population and sample, Null hypothesis and Alternative hypothesis, Single and two tailed test, Testing of hypothesis, Level of significance, Critical region, Procedure for testing of hypothesis. **[08 Hours]**

Text Books:

1. Fundamentals of Statistics by S. C. Gupta, Himalaya Publishing House Pvt. Ltd., New Delhi.
2. Probability and Statistics by Dr. B. B. Singh, Synergy Knowledgeware, Mumbai.
3. Mathematical Statistics by P. Mukhopadhyay, New Central Book Agency, Kolkata.
4. Fundamentals of Mathematical Statistics by S. C. Gupta and V. K. Kapoor, S. Chand and Sons, New Delhi.
5. An Introduction to Probability and Statistics by V. K. Rohatgi and A. K. Md. Ehsanes Saleh,Wiley Interscience Publication, New York.
6. Introduction to Probability and Statistical Applications by P. L. Meyer, Addison Wesley Publishing Co., Massachusetts.

Reference Books:

1. Probability, Statistics with Reliability, Queuing and Computer Science Applications by KishorS. Trivedi, Wiley India Pvt. Ltd., Mumbai.
2. Probability, Queuing Theory and Reliability Engineering by G. Haribaskaran, Laxmi Publications, New Delhi.
3. Probability and Statistics by R. S. Murray, J. S. John, R. Alu Srinivasan and D. Goswami,
   Schaum's Outlines series, McGraw Hill Publications, New Delhi.
4. Introduction to Theory of Statistics by A. M. Mood, F. A. Graybill and D. C. Boes, TataMcGraw – Hill Publications, Pune.

Automobile Engineering Lab IV

BTACL606	Automobile Engineering Lab III	PCC 14	0L-0T-6P	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 6hrs/week	Continuous Assessment: 60 Marks Mid Semester Exam: -- End Semester Exam: 40 Marks(Duration 03 hrs)

Vehicle Dynamics (Part A)
ListofPractical's/Experiments/Assignments (Any THREE)

1. Determination of the center of gravity location for a vehicle.
2. Determination of brake force distribution for a vehicle.
3. Demonstration of steering system and measurement of steering geometry angle and their impact on vehicle performance.
4. Multi body simulation for steering and suspension components using any FEA or MBD software.
5. Analysis of vehicle vibration signature using any analysis software.
6. To study the shock absorber and plot the transmissibility curve.
7. To verify analytically and experimentally traction requirementfor a vehicle.
8. To plot the torque requirement of a vehicle with respect to change ingradability.
9. To study Low speed maneuverability parameters of a vehicle.
10. To perform modal analysis of a suspension system.
11. To determine the natural frequency of damped vibration of single degree freedom system and to find it's damping coefficient.
12. To determine the frequency response curve under different damping conditions for single degree freedom system of vibration

Automobile Air Conditioning (Part B)(Any Four)
List of Experiments: -

1. Demonstration of different components with the help of cut sections/models/charts-Compressor, Condenser, Evaporators, Expansion device, Blower fans, Hating systems etc.
2. Test on vapor compression test rig.
3. Test on air conditioning test rig.
4. Demonstration of various methods of goods transport refrigeration systems.
5. Study and demonstration on car and bus air conditioning system.
6. Study of latest trends in automotive refrigeration systems.
7. Study and demonstration of controls in refrigeration.
8. Study of installation/operations/maintenance practices for refrigeration systems.
9. Study of leak testing and leak detection methods.
10. Visit to maintenance shop of automotive air conditioning and prepare report on it.

Electricals and Electronics Lab (Part C)
ListofPractical's/Experiments/Assignments(**ANY THREE**.)

1. Demonstration of automotive electrical and electronic systems layout.
2. Study/Demonstration and testing of battery performance parameter.
3. Demonstration and testing of alternators.
4. Demonstration and testing of starting motors & Electronic ignition system.
5. Demonstration of dash board panel instruments & controls.
6. Demonstration of headlight beam alignment.
7. Testing of auto electrical components on multifunctional tester.
8. Testing of CDI coil, spark plug and armature.
9. Study of ECU diagnostic system for fault finding.
10. Visit to any authorized service station for On Board Diagnosis.

B. Tech Seminar

BTAS607	Seminar II	PROJ-3	0L-0T-2P	1 Credits

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

Objective:

- To expose and make students aware with latest research and research publications
- To understand the research and research publication, references, citation
- To enhance the presentation skill
- To enhance the report writing
- To make the student aware about research publication sites

Students are expected to prepare a seminar report on the chosen topic/area selected with the discussion of chosen guide based on the available literature on the chosen topic.

Mini Project

BTAP608	Mini Project	PROJ-4	0L-0T-2P	1 Credits

Teaching Scheme:	**Examination Scheme:**
Practical: 2 hrs/week	Continuous Assessment: 60 Marks Mid Semester Exam: -- 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.

SEMESTER VII

Vehicle Performance and Testing

BTAC701	Vehicle Performance and Testing	PCC 15	3L-1T-0P	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 performance parameters related to performance analysis of automotive systems.
CO2	Conduct the performance test for components and systems of vehicle.
CO3	Explain the different tracks used for vehicle testing with the testing procedure.
CO4	Apply the knowledge regarding safety systems, EMI and sensors used for automotive functioning.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit-I:
Vehicle Performance Parameters:
Fuel economy, acceleration, deceleration, grad ability, top speed, handling, comfort, life durability, EGR systems, Impact of vehicular systems on performance: Suspension system, Steering system, Brakes, Tyres, carriage unit. Catalytic converters function and construction, Lambda close loop control system for gasoline vehicles.

Unit-II:
Drive train and Component testing:
Vehicular transmission performance: comparison of automotive clutches epicyclic transmission, torque converter, final drive and differential. testing of vehicle components: clutch, gear box (for noise and shifting force), brake testing, wheels and tyre testing – tyre wear pattern identification and causes.

Unit-III:
Vehicle testing:
Road test, free acceleration test, coast down test, passer by noise test, road load data acquisition for vehicle.
Test tracks: Proving ground testing, high speed track, pavement track, corrugated track, mud track, steering pad, gradient track, deep wading through shallow water Laboratory testing: Testing on chassis dynamometer, transition testing (Euro III onwards), accelerated testing, virtual testing, evaporative emission testing, oil consumption testing, endurance test, high

speed performance test.

Unit-IV:
Comfort, Convenience and Safety
Seats: types of seats, driving controls accessibility, and driver seat anthropometry.
Steering: steering column angle, collapsible steering, and power steering. Adaptive cruise control, navigation system, adaptive noise control, driver information system.
Safety: Motor vehicle safety standards, active safety, passive safety, bio-mechanics Structural safety, energy absorption, ergonomic consideration in safety.

Unit-V:
Collisions and Crash Testing Crash testing:
Human testing, dummies, crashworthiness, pole crash testing, rear crash testing, vehicle to vehicle impact, side impact testing, crash test sensors, sensor mounting, crash test data acquisition, braking distance test.

Noise and vibration:
Mechanism of noise generation, engine noise and vibration, causes and remedies on road shocks, wind noise and measurement. Automobile testing instrumentation: Sensors types and selection, instrumentation for functional tests, model test and full scale testing.

Texts/References: -

1. "Automotive Handbook", Bosch.
2. "Engine Testing Theory and Practice", Michel Plint.
3. "Motor Vehicle Inspection", W. H. Crouse and D. L. Anglin.
4. "Automobile Engineering" (Anna University) Ramlingam.
5. "Automobile engineering", Kripal Singh.
6. "Automotive Mechanics", JosepfHeitner.
7. ARAI vehicle emission test manual Inspection SAE handbook vol. 2 and 3.
8. "Vehicle Operation and Performance", J. G. Giles,
9. "Automobile engineering" Kripal Singh.
10. "Automotive Vehicle Safety", George Pieters, Barbara Pieters.
11. "Aerodynamics of road vehicles", Wolt, Heinrich Hucho.
12. "Engine performance Diagnosis and Tune up Shop Manual", Gousha H. M.
13. "Automobile Engineering", Rangawala.

Industrial Engineering and Management

BTHM702	Industrial Engineering and Management	HSSMC4	3L-1T-0P	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks

Tutorial: 1 hr/week	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
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
Staffing: Human resource management and selection, orientation, apprentice training and Apprentice Act (1961), performance appraisal and career strategy, job evolution and merit rating, 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
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
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
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.

Texts:

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
Design & Manufacturing of Automotive Components

BTAPE703A	Design &Manufacturingof Automotive Components	PEC 5	3L-0T-0P	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)

Unit I: Design Of Shaft

Materials used for shaft, manufacturing of shaft and types of shaft, Standard size of transmission shafts, stresses in shafts Maximum permissible working stresses for transmission for transmission shafts Design of shaft- shaft subjected to twisting moment only, shaft subjected to bending moment, shaft subjected to combined twisting moment and bending moment Design of shaft subjected to fluctuating load, axial load in addition to combined torsion and bending loads Design of shaft on the basis of rigidity

Unit II: Design of Cylinder And Piston

Introduction to I.C engines and components Materials selection based on engine components and its function-
Design of cylinder block and cylinder. Description on function of piston in an I.C engines- Design of Piston Description on piston rings-compression ring-oil rings, piston failure

Unit III: Design of Connecting Rod 8

Introduction - material selection for connecting rod Design of connecting rod small end Design of connecting rod big end and shank design Design of connecting rod-cap bolt design

Unit IV: Design of Crankshaft 8

Introduction about crank shaft and its function in an I.C Engine. Materials selection for crankshaft Balancing of I.C. engines, MI of Crankshaft, significance of firing order. Design of crankshaft under bending and twisting, balancing weight calculations. Development of short and long crank arms. Front and rear end
Details. Matrix from element stiffness

Unit V: Design of Cylinder Head and Valve Actuating

Mechanisms Introduction about cylinder block and head in an I.C Engine Design of cylinder block head, bolt loads and gasket Design of valve spring and valves Design of push rod

Text Books:

1. Kulkarni S. G, “Machine Design”, Tata McGraw-Hill Education, 2008.
2. Bhandari V, “Design of Machine Elements”,Tata McGraw-Hill Education, 2010.

Reference Books/Other Reading Material

1. William Orthein, “Machine Component Design”, Jaico Publishing House, 1998 - 99.
2. Shigley J, “Mechanical Engineering Design”, Mc Graw Hill, 2001.
3. Joseph Edward Shigley and Charles R.Mischke, “Mechanical Engineering Design”,McGraw-HillInternational Edition, 1989.
4. Gitin M.Maitra and LN Prasad, “Hand Book of Mechanical Design”, Tata McGraw Hill, 1985.
5. Spots M. F, “Design of Machine Elements”, Prentice Hall of India Private Ltd., New Delhi, 1983.
6. William Orthwein, “Machine Component Design”, Vol. I and II, Jaico Publising house, Chennai, 1996

7. Design Data, PSG College of Technology, 2008.

Virtual Reality

BTAPE703B	Virtual Reality	PEC 5	3L-0T-0P	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	Apply the concept in Automobile industry
CO2	Model and simulate real life problem of Automobile industries.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												

Course Contents:

Unit -I: Introduction: A short history of early virtual reality, early commercial VR Technology, VR becomes an Industry, The five classical components of VR Systems.
Input Devices: Trackers, Navigations and Gesture Interfaces.
Three-Dimensional Position Trackers: Tracker performance parameters, Mechanical trackers, Magnetic trackers, Ultrasonic trackers, Optical Trackers and Hybrid Inertial Trackers Navigation and Manipulation Interfaces: Tracker based Navigation/Manipulation Interfaces, Trackballs, and three Dimensional Probes Gesture Interfaces: The Pinch Glove, the 5DT Data Glove, the Dijiglove, Cyberglove.

Unit -II: Output Devices:
Graphical, Three-Dimensional Sound and Haptic Displays:
Graphical Display: The human visual system, personalgraphics displays, large volume displays. Sound displays: the human auditory system, the convolvotron, and Speaker based three-dimensional sound. Haptic Feedback: The human haptic system, Tactile Feedback Interfaces, Force Feedback Interfaces

Unit -III: Computing Architectures for Virtual Reality: The Rendering Pipeline: The graphical rendering pipeline, the haptics rendering pipeline. PC Graphics Architectures: PC Graphics Accelerators, Graphics Benchmarks. Work Station Based Architectures: The Sun Blade 1000 Architecture, The SGI Infinite Reality Architecture, Distributed VR Architectures: Multipipeline Synchronization, Collocated rendering Pipelines, Distributed Virtual Environments.
Modelling:
Geometric Modelling: Virtual Object Shape, Object Visual Appearance. Kinematics Modelling: Homogeneous Transformation Matrices, Object Position, Transformation Invariants, Object Hierarchies, viewing the three-dimensional words. Physical Modelling:

Collision Detection, Surface Deformation, Force Computation, Force Smoothing and Mapping, Haptic Texturing. Behaviour Modelling and Model Management: Level of Detail Management, Cell Segmentation.

Unit -IV: Virtual Reality Programming: Toolkits and Scene Graphs. World Toolkit: Model Geometry and Appearance, The WTK Scene Graph, Sensors and Action Functions, WTK Networking, JAVA 3D: Model Geometry and Appearance, Java 3D Scene graph, Sensors and Behaviours, Java 3D Networking, WTK and Java 3D Performance Comparison. General Haptics Open Software Toolkit: GHOST Integration with the Graphics Pipeline, The GHOST Haptic Scene Graph, Collision Detection and response, Graphics and PHANTOM Calibration.
Human Factors in Virtual Reality: Methodology and Terminology: Data Collection and Analysis, Usability Engineering Methodology. User Performance Studies: Test bed Evaluation of universal VR Tasks, Influence of System Responsiveness on User Performance, Influence of Feedback Multimodality.

Unit –V: Traditional Virtual Reality Applications: Medical Application, Virtual Anatomy, Triage and Diagnostic and Rehabilitation. Education, Arts and Entertainment: VR in Education, VR and, Surgery the Arts, Entertainment Application of VR. Military VR Application: Army use of VR, VR Application in Navy, Air Force use of VR.
Emerging Application of VR: VR Application and Manufacturing: Virtual Prototyping, other VR Application in Manufacturing; Application of VR in Robotics: Robot Programming, Robot Teleoperation. Information Visualization: Oil Exploration and Well Management, Volumetric Data Visualization

References

1. Grigore Burdea, Philippe Coiffet, “Virtual Reality Technology”, 2nd edition. Wiley India
2. John vince, “Virtual Reality Systems”, Pearson Education Asia
3. “Understanding Virtual Reality”, Sherman, Elsevier.

Actuation System

BTAPE703C	Actuation System	PEC 5	3L-0T-0P	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	Acquire characteristics of the fluid and air.
CO2	Design, operation and use of hydraulic machines
CO3	Design, operation and use of pneumatic machines

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit- I:
Types of hydraulic fluids, functions of hydraulic fluids, advantages of a fluid power system, basic components of a hydraulic system, basic components of a pneumatic system, comparison of different power systems.Governing principles and laws: Pascal's law, force power and force displacement relations, practical applications of pascal's law and evaluate the parameters.

Unit- II:
Hydraulic Pumps:
Classification of Pumps based on- displacement, delivery and motion, Differences between positive displacement pumps and non-positive displacement with Performance curves, working and construction of gear, vane and piston pumps, mechanical, volumetric and overall efficiency of pumps (numerical treatment), performance parameters of gear, vane and piston pumps.

Unit-III:
Hydraulic Actuators:
Classification, types of hydraulic cylinders - single-acting cylinders, gravity-return single-acting cylinder, spring-return single-acting cylinder, double-acting cylinder, telescopic cylinder, tandem cylinder, graphical symbols of different linear actuators, classification of dcvs, shuttle valves, two-way valves, three-way valves. Four-way valves. Advantages of a

poppet valve and Disadvantages, graphic symbols for various types of direction control valves, and its applications, working principle of solenoid-actuated valves

Unit-IV:

Hydraulics Circuit:

Control of a Single-Acting and Double-Acting Hydraulic Cylinder Hydraulic Cylinder, Regenerative Cylinder Circuit, Load-Carrying Capacity During Extension, Pump-Unloading Circuit, Double-Pump Hydraulic System, Counterbalance Valve Application, Hydraulic Cylinder Sequencing Circuits, Locked Cylinder Using Pilot Check Valves, Cylinder Synchronizing Circuits, Speed Control of a Hydraulic Cylinder.

Unit-V:

Pneumatics:

Principle of Pneumatics: Laws of compression, types of compressors, selection of compressors, Comparison of Pneumatics with Hydraulic power transmissions, Types of filters, regulators, lubricators, mufflers, dryers, Pressure regulating valves, Direction control valves, two way, three way, four way valves. Solenoid operated valves, push button, Pneumatic actuators-rotary, reciprocating. Air motors- radial piston, vane, axial piston, Basic pneumatic circuit, Direct and indirect control of single and double acting cylinder.

Typical Automotive Applications:

Power steering, fork lift hydraulic gear, hydro-pneumatic suspension (Air suspension), Clutch actuating System, Pneumatic circuit to control the door of vehicle, air brake and maintenance and troubleshooting of pneumatic circuits

Accumulators: Types, applications of accumulators**.** Accumulator as a hydraulic shock absorber.

Texts/References:

1. “Pneumatic Systems”,S. R. Majumdar, Tata McGraw Hill 1996.
2. “Oil Hydraulics- Principle and Maintenance”, S. R Majumdar, Tata McGraw Hill 2002.
3. “Industrial Hydraulics”,J. J. Pipenger, McGraw Hill
4. “Industrial Fluid Power”, Pinches, Prentice hall
5. “Basic Fluid Power”,D. A. Pease, Prentice hall
6. “Hydraulics and Pneumatics”, H. L. Stewart, Industrial Press

Electric and Hybrid Vehicles

BTAPE703D	Electric and Hybrid Vehicles	PEC 5	3L-0T-0P	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 need of EVs and HEVs in today's transportation context.
CO2	Describe and compare EV and HEV technology.
CO3	Suggest factors to design an electric vehicle.
CO4	Comment on significance of fuel cell technology for vehicular application
CO5	Explain nonelectrical hybrid systems for vehicle.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit -I:
Electric Vehicles and Motors
Electric vehicle, introduction, components, advantages, disadvantages, applications, vehicles. DC motors series wound- shunt wound- compound wound and separately excited motors AC motors Induction- synchronous- brushless DC motor- switched reluctance motors.

Unit -II:
Hybrid Vehicles and Propulsion Methods
Introduction to hybrid vehicles performance characteristics of road vehicles; calculation of road load- predicting fuel economy- grid connected hybrids.

Unit -III:
Hybrid Architecture and Power Plant Specifications
Series configuration locomotive drives- series parallel switching- load tracking architecture. Pre transmission parallel and combined configurations Mild hybrid- power assist- dual mode- power split- power split with shift- Continuously Variable transmission (CVT) - wheel motors. Grade and cruise targets- launching and boosting- braking and energy recuperation- drive cycle implications.

Unit -IV:
Sizing the Drive System and Energy Storage Technology
Matching electric drive and ICE, sizing the propulsion motor; sizing power electronics, Batterybasics: lead acid battery, different types of batteries, battery parameters, advanced

battery technology.

Unit-V:

Fuel Cells

Fuel cell characteristics- fuel cell types – alkaline fuel cell- proton exchange Membrane; direct methanol fuel cell- phosphoric acid fuel cell- molten carbonate fuel cell- solid oxide fuel cell- hydrogen storage systems- reformers- fuel cell EV- super and ultra-capacitors- PEM fuel cell vehicles

Nonelectric Hybrid Systems

Short term storage systems flywheel accumulators, continuously variable transmissions hydraulic accumulator's hydraulic pumps/motors- pneumatic hybrid engine systems operation modes.

Text Books:

1. "The Electric Car: Development and Future of Battery- Hybrid and Fuel Cell Cars", Mike Westbrook- M H Westbrook- British library Cataloguing in Publication Data.
2. "Electric and Hybrid Vehicles", Robin Hardy- Iqbal Husain- CRC Press.
3. "Propulsion Systems for Hybrid Vehicles", John M. Miller Institute of Electrical Engineers- London.
4. "Alternative Fuels", S.S. Thipse, Jaico publications.

Reference Books:

1. Energy Technology Analysis Prospects for Hydrogen and Fuel Cells- International Energy Agency- France.
2. Handbook of Electric Motors- Hamid A Toliyat- Gerald B Kliman- Marcel Decker Inc.

Automotive Safety & Regulations

BTAPE703E	Safety & Regulations (Automotive)	PEC 5	3L-0T-0P	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 Contents:

Unit 1:

INTRODUCTION Design of the body for safety, energy equation, engine location, deceleration of vehicle inside passenger compartment, deceleration on impact with stationary and movable obstacle, concept of crumble zone, safety sandwich construction.

Unit:2:

SAFETY CONCEPTS Active safety: driving safety, conditional safety, perceptibility safety, operating safety passive safety: exterior safety, interior safety, deformation behavior of vehicle body, speed and acceleration characteristics of passenger compartment on impact.

Unit:3:

SAFETY EQUIPMENTS Seat belt, regulations, automatic seat belt tightener system, collapsible steering column, tilt able steering wheel, air bags, electronic system for activating air bags, bumper design for safety.

Unit:4

COLLISION WARNING AND AVOIDANCE Collision warning system, causes of rear end collision, frontal object detection, rear vehicle object detection system, object detection system with braking system Interactions.

Unit:5

COMFORT AND CONVENIENCE SYSTEM Steering and mirror adjustment, central locking system , Garage door opening system, tyre pressure control system, rain sensor system, environment information system

Text & Reference Books:

1. Bosch - “Automotive Handbook” - 5th edition - SAE publication - 2000.
2. J.Powloski - “Vehicle Body Engineering” - Business books limited, London - 1969.
3. Ronald.K.Jurgen - “Automotive Electronics Handbook” - Second edition- McGraw-Hill Inc., - 1999.

Motor Insurance Practices

BTAPE703F	Motor Insurance Practices	PEC 5	3L-0T-0P	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: Automobile Engineering.

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

CO1	Classify motor vehicle insurances.
CO2	Discuss applications of insurance principles in vehicle insurance.
CO3	Describe various forms in motor vehicle insurance.
CO4	Discuss MACT in detail.
CO5	Analyze fraud management and internal audit in relation with motor vehicle insurance.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Principles of Insurance and Motor Insurance:
History of Insurance, Business of Insurance, Transfer of Risk, Classification of Insurance – Life & General Insurance, Market Role of Specialist (e.g. Surveyor)
History of Motor Insurance: Law and Practice of Motor Insurance in India: Applicability of Principles of Insurance: Total Loss (TL) / Constructive Total Loss (CTL) / Theft Claims: Legal Aspects of Insurance, Act No. 59 of 1988 (The Motor Vehicles Act, 1988) The Motor Vehicles (Amendment) Bill, 2008 – Part B: Key Issues and Analysis.

Unit 2: Type of motor vehicles, documents and policies:
Types of Motor Vehicles – Meaning and classification of motor vehicles – Motor insurance documents – Proposal form – Proposal form for 'Liability Only Policy' – Certificate of Insurance – Cover Note – Policy forms – Endorsement – Renewal notice – E-insurance to come into existence from next year – Types of Motor Policies – Coverage for motor policies – Coverage for Private Car – Coverage for Two Wheeler – Coverage for Commercial Vehicles – Motor trade policies – Motor Trade Internal Risks Policy – New technologies – In-car Technologies – New technology in auto field.

Unit 3: Motor Insurance Claims:

Motor Insurance Claims, Doctrine of cause of Accident, Motor Insurance Claims Procedures, Claim Documents, Types of Losses, Various Causes of Accident, Salvage/Scrap Disposal, Accident Repairing Cost, Compensation for Third Party Injury or Property Damage, The Consensus vs. Scientific Approach, Science of Damage Estimation and the Technology Support – Surveyor and His role in Loss Minimisation – Role of Surveyor – Steps in Motor Survey – Guidelines on Automobile Survey – Role of Motor Surveyor in Loss Minimisation – Role of Road Safety in Insurance – Concerns of Community – Road Safety Promotion by Insurance – Causes of Accident – Role of Fleet Operators – Underwriting in Motor Insurance, Transport Development Council – Roadside Assistance – Exclusions in Road Side Assistance – Frauds in Motor OD Claims – Seamless Claims Management – Frauds in motor insurance – Way to Mitigate Frauds**.**

Unit 4: Marketing in Motor Insurance:

Market practice of Motor Insurance in India – Caveats for filing add-on covers – Guidelines applicable in India – India Motor Tariff 2002 – Amendments subsequent to discontinuance of tariff – Tariff system after detariffing – International practice in motor insurance rating – Underwriting in motor insurance – Principles and practice of premium computation – Introduction – Indian Motor Insurance market – Model wise Risk assessment – Motor Underwriting.

Motor Third Party Pool – Dysfunctional Motor Market – Motor Third Party Pool – Review of Pool – Knock for Knock Agreement – International Issues in Insurance Markets – International Translation of Driver's License – Some Market Practices.

Unit 5: IT Applications in Motor Insurance:

Importance of Analytics and IT Intervention – IT Intervention and Competition – IT Intervention and Data Analytics – Need for and Importance of Statistics – TAC as Data Depository – TAC as National Repository for Statistical Data.

Fraud Management and Internal Audit:

Frauds in TP Claims – Frauds in Motor Insurance – Types of Fraud – Underwriting Frauds – Methods of Detection of underwriting fraud – Frauds Committed with Internal Support – Preventive Management of Fraud Cases – Issues to be Audited**.**

Text Books:

1. Handbook on Motor Insurance – IRDA
2. Automobile Insurance – Actuarial Model: Lemaire Jean, Springer

Reference Books:

1. Motor Vehicle Act, 1988 together with Central Motor Vehicle Rules, 1989, Eastern Book Company, Lucknow, 2nd Edition 1989.
2. Lemaire Jean, Automobile Insurance – Actuarial Model, Springer
3. Georges Dionne HEC, Montreal, Automobile Insurance: Road Safety, New Drivers, Risks, Insurance Fraud and Regulation, Springer
4. P S Palande, R S Shah, M L Lunawat, Insurance in India: Changing Policies and Emerging Opportunities, SAGE Publications

5. IRDA website https://www.irdai.gov.in

Biomechanics

BTMPE703B	Biomechanics	PEC 5	3L-0T-0P	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 various forces and mechanisms and define Newton's law of motion, work and energy, moment of inertia
CO2	Describe forces and stresses in different human joints
CO3	Discuss bio fluid mechanics in cardiovascular and respiratory system in human body
CO4	Differentiate between hard tissues and soft tissues
CO5	Understand concepts of implants and Identify different techniques used in biomechanics implants

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	1			1	1	1	1		1	1
CO2	2	2	2			1	2		1		1	1
CO3	2	2	2			1	1	1	1			1
CO4	1	1	1				1	1	1			1
CO5	1	1	2				1	1			1	1

Course Contents:

Unit 1: Introduction
Review of principle of mechanics, vector mechanics-resultant forces of coplanar and non-coplanar and concurrent and non-concurrent forces, parallel forces in planes, equilibrium of coplanar forces, Newton's law of motion, work and energy, moment of inertia.

Unit 2: Biomechanics of Joints
Skeletal joints, forces and stresses in human joints, type of joints, biomechanical analysis of elbow, shoulder, spinal column, hip knee and ankle.

Unit 3: Bio-fluid Mechanics
Introduction, viscosity and capillary viscometer, Rheological properties of blood, laminar flow, cardiovascular and respiratory system.

Unit 4: Hard Tissues
Bone structure and composition, Mechanical properties of bones, cortical and cancellous bones, visco-elastic properties, Maxwell and Vigot model – Anisotropy

Unit 5: Soft Tissues
Structure and functions of soft tissue: cartilage, tendon, ligament and muscle, Material properties

of cartilage, tendon and ligament and muscle

Biomechanics of Implant

Specification for prosthetic joints, biocompatibility, requirement of biomaterial, characterization of different type of biomaterials, fixation of implants.

Texts/References:

1. Y. C. Fung, "Biomechanics: Mechanical properties of living tissues", Springer-Verlag, 2nd edition, 1993.
2. D. J. Schneck, J. D. Bronzino, "Biomechanics: Principle and Applications", CRC Press, 2nd edition, 2000.

Open Elective-III

Sustainable Development

BTMOE704A	Sustainable Development	OEC3	3L-0T-0P	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 development and sustainable development
CO2	Explain challenges of sustainable development and climate change
CO3	Explain sustainable development indicators
CO4	Analyze sustainable energy options
CO5	Understand social and economic aspects of sustainable development

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	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
CO5			3			2	3	2				1

Course Contents:

Unit 1: Introduction
Status of environment, Environmental, Social and Economic issues, Need for sustainability, nine ways to achieve sustainability, population, resources, development and environment.

Unit 2: Global Warming and Climate Change
Global Warming and climate Change since industrial revolution, Greenhouse gas emission, greenhouse effect, Renewable energy, etc.

Unit 3: Challenges of Sustainable Development and Global Environmental Issues
Concept of sustainability, Factors governing sustainable development, Linkages among sustainable development, Environment and poverty, Determinants of sustainable development, Case studies on sustainable development, Population, income and urbanization Health care, Food, fisheries and agriculture , Materials and energy flows.

Unit 4: Sustainable Development Indicators
Need for indicators, Statistical procedures Aggregating indicators, Use of principal component analysis, Three environmental quality indices.

Unit 5: Environmental Assessment
National environmental policy act of 1969, Environmental Impact Assessment,

Project categories based on environmental impacts, Impact identification methods, Environmental impact assessment process.
Environmental Management and Social Dimensions
Revisiting complex issues, Sector policies concerning the environment, Institutional framework for environmental management, Achievements in environmental management, People's perception of the environment, Participatory development, NGOs, Gender and development, Indigenous peoples, Social exclusion and analysis.

Texts:

1. J. Sayer, B. Campbell, "The Science of Sustainable Development: Local Livelihoods and the Global Environment", Biological Conservation, Restoration and Sustainability, Cambridge University Press, London, 2003.
2. J. Kirkby, P. O"Keefe, Timberlake, "Sustainable Development", Earth scan Publication, London, 1993.
3. Peter P. Rogers, Kazi F. Jalal, John A. Boyd, "An introduction to sustainable development", Glen Educational Foundation, 2008.

References:

1. Jennifer A. Elliott, "An introduction to sustainable development". London: Routledge: Taylor and Francis group, 2001.
2. Low, N. "Global ethics and environment", London, Rout ledge, 1999.
3. Douglas Muschett, "Principles of Sustainable Development", St. Lucie Press, 1997.

Entrepreneurship Development

BTMOE704B	Entrepreneurship Development	OEC 3	3L-0T-0P	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	enlarge the supply of entrepreneurs for rapid industrial development
CO2	Develop small and medium enterprises sector which is necessary for generation of employment
CO3	Industrialize rural and backward regions
CO4	Provide gainful self-employment to educated young men and women
CO5	Diversify the sources of entrepreneurship.

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			
CO2									2			
CO3											2	
CO4											2	3
CO5												3

Course Contents:

Unit 1: Introduction to Entrepreneurship
Evolution of the Concept of Entrepreneur Functions of Entrepreneur, Characteristics of an Entrepreneur, Types of Entrepreneur, Concept of Entrepreneurship, Growth of Entrepreneurship, Barriers of Entrepreneurship, Role of Entrepreneurship in India, Entrepreneurial Motivation, Major Entrepreneurial Competencies.

Unit 2: Small Scale Industries (SSI)
Characteristics of Small Scale Industry, Basis for Classification of Small Scale Industry: Resource Based, Demand Based, Ancillary, Subsidiary Based or Sub-Controlled Type, Technology Based etc. Government Policy for Small Scale Industry, Growth of SSI in Developing Countries, Role of National and State Agencies Providing Assistance To SSI's, Relationship between Small and Big Industries, Ownership Structure, Registration of SSI.

Unit 3: Project Identification and Project Formulation
Meaning of Project, Project Identification and Selection, Elements of Project Formulation, Concept and Significance of Project Formulation, Meaning, Significance and Contents of Project Report.

Accounting for Small Enterprises: Objective of Accounting, Accounting Process, Journal, Ledger, Preparation of Balance Sheet and Assessment of Economic Viability

Unit 4: Project Appraisal

Concept of Project Appraisal, Project Appraisal Methods, Cash Flows as Costs and Benefits, Payback Period, Average Rate of Return. Discounted Cash Flow Techniques, Working Capital Management, Cost of Capital, Financing of Enterprises, Project Sickness & Corrective Measures.

Unit 5: Marketing Management
Market Segmentation, Marketing Mix, and Packaging, Pricing Policy, Distribution Channels, and Govt. Purchases from SSIS.
Laws Concerning Entrepreneur: Income Tax Laws, Excise Duty ,The Central Sales Tax Act, Professional Tax, Value Added Tax (VAT), Service Tax, The Workmen Compensation Act, The Minimum Wages Act, The Maternity Benefit Act, The Payment of Bonus Act
Institutional Support
Government Policies for Small Scale Entrepreneurs, Institutional Setup, District Industries Centers, Industrial Estates , SIDCO, NSIC, Directorate of Industries, Commercial Banks, New Entrepreneurial Development Agencies.
Women Entrepreneurship: Growth, Problems, Recent Trends.

References:

1. S. S. Khanka, “Entrepreneurial Development”, S. Chand and Company Ltd.
2. C. B. Gupta, N. P. Srinivasan, “Entrepreneurship Development in India”, S. Chand and Sons.
3. B. Badhai, “Entrepreneurship Development Programme”, Mansell Publishing Ltd.
4. V. Desai, “Dynamics of Entrepreneurial Development and Management”, Hindustan Publishing House.
5. David H. Holt, “Entrepreneurship”, PHI Learning.
6. Roy Rajeev, “Entrepreneurship”, Oxford University Press.

Plant Maintenance

BTMOE704C	Plant Maintenance	OEC 3	3L-0T-0P	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)

Objectives: To exemplify different types of plants and its function and analyse the principles used in plants maintenance. To understand various basic aspects related to running of industry the safety methods in plants. This course provides problems based techniques related with location, layout, maintenance, replacement of machines, etc.
Pre-Requisites: None

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

CO1	Recognize and enlist probable failures in mechanical elements.
CO2	Dismantle, assemble and align mechanisms in sequential order for given assembly.
CO3	Compare maintenance practices like on-line, shut down, corrosion, productive and preventive maintenance.
CO4	Analyze economics of plants and list factors affecting the maintenance of a plant.
CO5	Correlate the linkages between different maintenance aspects and how they impact on overall maintenance effectiveness.
CO6	Analyze different maintenance techniques and select an appropriate technique for a particular plant.

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		1	2	1	1	2			2
CO2	2			1	1	2	2					2
CO3	2	2	1	1	1		1	1	1			
CO4	1	1		2	1	2	1		2		1	2
CO5	2	2			1	2	2				1	2
CO6	1					1					1	1

Course Contents:

Unit 1: Introduction
Introduction to concept of maintenance, Type of maintenance; Preventive, Productive, corrective, online, shut down and their significance.

Unit 2: Preventive Maintenance
Preventive maintenance and its importance, Repair cycle, systematic recording, preventive maintenance, Programming and types of schedules, Manpower and machine planning, Lubrication methods and practice, Color code schedule.

Unit 3: Online Maintenance
On-line maintenance, attending to joints, Valves, Pumps and other equipment's leakages, Making shaft arrangement, stand-by unit, repairing damage to insulation, etc. without stopping the plant, attending faulty equipment, Fault finding and troubleshoots.

Unit 4: Shut down Maintenance

Shut down maintenance, Economic aspects of timing, duration of Timing and duration of shut down maintenance, Execution by using PERT and CPM.

Unit 5: Maintenance of Mechanical Equipment
Maintenance of major equipment like boiler, furnaces, kilns, shells and tube heat exchangers, pump and compressor, Towers, Cooling vessels, Valves piping.
Plant Condition Monitoring
Plant condition monitoring systems, instrumentation, Data collection and analysis, life expectancy and maintenance scheduling. The economics of maintenance management.

Text:

1. Lindley R. Hinggin, L.C. Morrow, "Maintenance Engineering Handbook", Tata McGraw Hill Book Company.

References:

2. Duncan C. Richardson, PE, "Plant Equipment and Maintenance Engineering Handbook", McGraw Hill Education, New York, Chicago, 2014.

Open Elective-IV

Engineering Economics

BTMOE705A	Engineering Economics	OEC 4	3L-0T-0P	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	Apply the appropriate engineering economics analysis method(s) for problem solving: present worth, annual cost, rate-of-return, payback, break-even, Benefit-cost ratio.
CO2	Evaluate the cost effectiveness of individual engineering projects using the methods learned and draw inferences for the investment decisions.
CO3	Compare the life cycle cost of multiple projects using the methods learned, and make a quantitative decision between alternate facilities and/or systems.
CO4	Compute the depreciation of an asset using standard Depreciation techniques to assess its impact on present or future value.
CO5	Apply all mathematical approach models covered in solving engineering economics problems: mathematical formulas, interest factors from tables, Excel functions and graphs. Estimate reasonableness of the results.
CO6	Examine and evaluate probabilistic risk assessment methods.
CO7	Compare the differences in economic analysis between the private and public sectors. Recognize the limits of mathematical models for factors hard to quantify.
CO8	Develop and demonstrate teamwork, project management, and professional communications skills

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1											3	
CO2											3	
CO3											3	
CO4											3	
CO5					3						3	
CO6											3	
CO7											3	
CO8									2		3	

Course Contents:

Unit 1: Introduction to Economics

Introduction to Economics: Flow in an economy, Law of supply and demand, Concept of Engineering Economics: Engineering efficiency, Economic efficiency, Scope of engineering economics - Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis: V ratio, Elementary economic Analysis: Material selection for

product Design selection for a product, Process planning.

Unit 2: Value Engineering
Make or buy decision, Value engineering: Function, aims, and Value engineering procedure. Interest formulae and their applications: Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor: equal payment series capital recovery factor:
Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods.

Unit 3: Cash Flow
Methods of comparison of alternatives: present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method, Examples in all the methods.

Unit 4: Replacement and Maintenance Analysis
Replacement and Maintenance analysis: Types of maintenance, types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset: capital recovery with return and concept of challenger and defender, Simple probabilistic model for items which fail completely.

Unit 5: Depreciation
Depreciation: Introduction, Straight line method of depreciation, declining balance method of depreciation, sum of the years digits method of depreciation, sinking fund method of depreciation/annuity method of depreciation, service output method of depreciation-
Evaluation of Public Alternatives
Introduction, Examples, Inflation adjusted decisions: procedure to adjust inflation, Examples on comparison of alternatives and determination of economic life of asset.

Texts:

1. PanneerSelvam R, “Engineering Economics”, Prentice Hall of India Ltd, New Delhi, 2001.

References:

1. Chan S. Park, “Contemporary Engineering Economics”, Prentice Hall of India, 2011.
2. Donald G. Newman, Jerome P. Lavelle, “Engineering Economics and analysis”, Engineering Press, Texas, 2010.
3. E. P. Degarmo, W. G. Sullivan and J. R. Canada, “Engineering Economy”, Macmillan, New York, 2011.
4. Zahid A. Khan, "Engineering Economy", Dorling Kindersley, 2012.

Biology for Engineers

BTMOE705B	Biology for Engineers	OEC 4	3L-0T-0P	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 origin of life and Evolution, Cells, Biomolecules-Lipids
CO2	Understand Biomolecules
CO3	Understand Cell structure and function and cell cycle
CO4	Explain Mendelian genetics
CO5	Understand and Explain DNA structure, DNA replication, Transcription, Translation

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	1	2	3		1		1			1		1
CO2	1	2	3		1		1			1		1
CO3	1	2	3		1		1			1		1
CO4	1	2	3		1		1			1		1
CO5	1	2	3		1		1			1		1

Course Contents:

Unit 1: Introduction
Origin of life and Evolution, Cells, Biomolecules-Lipids

Unit 2: Biomolecules
Carbohydrates, water, Amino acids and proteins, Enzymes, Nucleotides

Unit 3: Cell structure
Cell structure and function, Prokaryotes, Eukaryotes

Unit 4: Cell cycle
Cell division, mitosis, meiosis, culture growth,

Unit 5: Genetics
Mendelian genetics, genetic disorders, Mendelian inheritance principle, pedigree analysis, Non- Mendelian inheritance

DNA
Chromatin, DNA structure, DNA replication, Transcription, Translation.

Texts:

1. Arthur T. Johnson, “Biology for Engineers”, CRC Press.

References:

1. N. A. Campbell, J. B. Reece, “Biology”, International edition, Benjamin Cummings, New York, 7th edition or later, 2007 or later.
2. G. Karp, “Cell and Molecular Biology: Concepts and Experiments”, Wiley, New York, 7th edition, 2013.

Intellectual Property Rights

BTMOE705C	Intellectual Property Rights	OEC 4	3L-0T-0P	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 the basic fundamental terms such as copyrights, Patents, Trademarks etc.,
CO2	Interpret Laws of copy-rights, Patents, Trademarks and various IP registration Processes.
CO3	Exhibit the enhance capability to do economic analysis of IP rights, technology and innovation related policy issues and firms commercial strategies.
CO4	Create awareness at all levels (research and innovation) to develop patentable technologies.
CO5	Apply trade mark law, copy right law, patent law and also carry out intellectual property audits.
CO6	Manage and safeguard the intellectual property and protect it against unauthorized use.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	1											
CO2								1				
CO3		1						1				
CO4										1		
CO5	1							1				
CO6								2				

Course Contents:

Unit 1: Introduction to Intellectual Property
Introduction, types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights.

Unit 2: Trade Marks
Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting and evaluating trade mark, trade mark registration processes.

Unit 3: Law of Copy Rights
Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law.

Unit 4: Law of Patents
Foundation of patent law, patent searching process, ownership rights and transfer.

Unit 5: Trade Secrets

Trade secretes law, determination of trade secretes status, liability for misappropriations of trade secrets, protection for submission, trade secrete litigation.

Unfair competition: Misappropriation right of publicity, false advertising.

New Development of Intellectual Property

New developments in trade mark law; copy right law, patent law, intellectual property audits.

International overview on intellectual property, international trade mark law, copy right law, international patent law, and international development in trade secrets law.

Texts:

1. Deborah, E. Bouchoux, "Intellectual Property Right", Cengage learning.
2. Prabuddha Ganguli, "Intellectual property right: Unleashing the knowledge economy", Tata McGraw Hill Publishing Company Ltd.

References:

1. Ajit Parulekar, Sarita D'Souza, "Indian Patents Law-Legal and Business implications", Macmillan India Ltd., 2006.
2. B. L. Wadhera, "Law related to patents, Trademarks, Copyrights, Designs and Geographical indications", Universal law Publishing Pvt. Ltd., India, 2000.
3. P. Narayanan, "Law of copyright and Industrial Designs", Eastern Law house, Delhi, 2010.

Automobile Engineering Lab V

BTACL706	Automobile Engineering Lab III	PCC 16	0L-0T-6P	3 Credits

Teaching Scheme:	Examination Scheme:
Lecture: 6hrs/week	Continuous Assessment: 60 Marks Mid Semester Exam: -- End Semester Exam: 40 Marks(Duration 03 hrs)

Vehicle Performance and Testing Lab (Part A)
List of Experiment: (Any Three)

1. Estimation of power requirement for vehicle propulsion by taking actual vehicle example.
2. Perform coast down test.
3. On road fuel consumption test at different speeds.
4. Brake efficiency measurement
5. Pass - by noise test.
6. Free acceleration test.
7. Vibration measurement in passenger compartment
8. Laboratory testing of vehicle on chassis dynamometer for performance and emission.
9. Report based on visit to vehicle testing and research organization.
10. Visit for on road emission testing of petrol and diesel vehicles for PUC/RTO.

Vehicle Maintenance Management Lab (Any Three)
List of Practical's/Experiments/Assignments:

1. Visit to Service Station to study computerized wheel alignment.
2. To check and adjust wheel balancing by using computerized wheel balancing machine
3. Demonstration of trouble shooting on multi cylinder petrol/diesel engine
4. Dismantle and assemble of two-wheeler single cylinder four stroke engine.
5. Trouble shooting of braking system.
6. Tune up the four stroke SI engine of a car for best performance.
7. To check and adjust valve clearance of four stroke SI engine of a car.
8. Visit to fuel injection pump testing station.
9. Dismantling and assembly of carburettor.
10. Demonstration of CNG fuel kit.
11. Demonstration of LPG fuel kit

Listof Practicals/Experiments/Assignments(Any Two)
A] Any One from experiment No. 1 to 5 and Any One from experiment No. 6 to 10

1. Determination of linear and angular dimensions of given composite part using precision/non precision measuring instruments.
2. Error determination with linear / angular measuring instruments.
3. Calibration of measuring instrument. Example – Dial gauge, Micrometer, Vernier (any one)
4. Verification of dimensions & geometry of given components using Mechanical & Pneumatic comparator.
5. Machine tool alignment testing on any two machines.
6. Identification of surfaces using optical flat/interferometers and measure surface roughness using surface roughness tester.
7. Determination of geometry & dimensions of given composite object using profile

projector and measurement of various angles of single point cutting tool using tool maker's microscope.
8. Measurement of thread parameters using floating carriage diameter measuring machine.
9. Measurement of spur gear parameters using Gear Tooth Vernier, Span, Gear Rolling Tester.
10. Determination of given geometry using coordinate measuring machine (CMM).

B] Statistical Quality Control (SQC) (Any Two)
Note - Use of computational tools are recommended

1. Analyze the fault in given batch of specimens by using seven quality control tools for engineering application.
2. Determination of process capability from given components and plot variable control chart/ attribute chart.
3. Case study on various tools in Total Quality Management (TQM).

C] Industrial visit to Calibration lab /Quality control lab / Gear manufacturing unit / Automotive Industry / Engineering Industry.

IT – 3

BTAI608 (IT – 3)	IT – 3 Evaluation	PROJ-5	0L-0T-0P	1 Credits

Teaching Scheme:	**Examination Scheme:**
Practical: -- hrs/week	Continuous Assessment: -- Mid Semester Exam: -- End Semester Exam: 100 Marks

SEMESTER VIII
Major Project

BTAP801/ BTAI801	Project work/ Internship	PROJ-6	0L-0T-24P	12 Credits

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

List of courses with their equivalent SWAYAM courses:

Sr. No.	Semester	Couese Code	Name of Subject as per Curriculum	Equivalent SWAYAM/ NPTEL Courses	Name of Institute offering course	Relevance %	Duration of course
1	1st	BTBS101	Engineering Mathematics-I		IIT Kharagpur	40	1. 10 Weeks 2. 6 Weeks
2		BTBS102	Engineering Physics	1.Engineering physics-I 2.Engineering physics-II	IIT Roorkee, IIT Kanpur	80	1. 12 Weeks 2.8 Weeks
3		BTES103	Engineering Graphics	Engineering drawing, Engineering graphics	IIT Guwahati	70	10 Weeks
4		BTHM104	Communication Skills	Communication skills	IIT Kanpur	50	1. 12 Weeks 2. 10 Weeks
5		BTES105	Energy and Environment Engineering	1.Environmental air pollution 2. Fundamentals of environmental pollution and control	IIT Kanpur, IIT Kharagpur	30	8 Weeks
6		BTES106	Basic Civil and Mechanical Engineering	Introduction to civil engineering profession	IIT Madras		

7	2nd	BTBS201	Engineering Mathematics-II	Engineering Mathematics II	IIT Kharagpur	20%	
				Engineering Mathematics - I	IIT Kharagpur	20%	
8		BTBS202	Engineering Chemistry	No course available			
9		BTES203	Engineering Mechanics	Engineering mechanics	IIT Madras	70	12 week
10		BTES204	Computer Programming	No course available			
11		BTES205	Basic Electrical and Electronics Engineering	No course available			
12	Semester III	BTBS301	Engineering Mathematics-III	Mathematics-III	IIT Roorkee	60%	10 week
				Engineering Mathematics	IIT Kharagpur	40%	12 week
					Gandhi Institute of Technology and Management, University in Visakhapatnam, Andhra Pradesh	100%	12 week
13		BTMC302	Fluid Mechanics	Introduction to Fluid Mechanics	IIT Kharagpur	80%	12 week
				Introduction to Fluid Mechanics and Fluid Engineering	IIT Kharagpur	100%	15 week
				Fluid Mechanics	IIT Guwahati	60%	6 week
				Fluid Mechanics	IIT Kharagpur	100%	10 week
				Fluid Mechanics	IIT Guwahati	80%	6 week
14		BTAC303	Thermodynamics & Heat Transfer	fundamentals of conduction and radation	IIT Guwahati	50%	9 week
				Applied Thermodynamics for Engineers	IIT Guwahati	60%	9 week
				Concepts of Thermodynamics	IIT Kharagpur	90%	12 week
				Thermodynamics	IIT Madras	40%	12 week
15		BTMES304	Materials Science and Metallurgy	Introduction to material science and enfineering	IIT Delhi	40%	12 week
				Introduction to Materials Science and Engineering	IIT Madras	50%	4 week
				Material science and engineering	IIT Roorkee	70%	10 week
16		BTACL305	Automotive Component Drawing and Computer Aided Drafting Lab				
17	Semester IV	BTAC401	Theory of Automotive Engines	IC engine and gas turbine	IIT Guwahati	80%	12 week
				Engine Combustion	IIT Kanpur	50%	10 week
18		BTPC402	Theory of Machines	Kinematics of mechanisms and machines	IIT Kharagpur	40%	10 week
				Dynamics of Machines	IIT Kharagpur	40%	11 week
19		BTHM403	Basic Human Rights				
20		BTMES404	Strength of Materials	Strength of Materials	IIT Roorkee	60%	9 week
				Strength of Materials	IIT Roorkee	50%	10 week
				Strength of Materials	IIT Madras	20%	2 week
				Gear and Gear Unit Design : Theory and Practice	IIT Kharagpur	20%	8 week

21		BTAPE405 A	Elective-I Automotive Materials	Surface Engineering for Corrosion and Wear Resistance Application	IIT Kharagpur	30%	12 week
				Fundamentals of Surface Engineering: Mechanisms,Processes and Characterizations	IIT Roorkee	20%	15 week
				Science and Technology of Polymers	IIT Kharagpur	20%	10 week
				Composite Materials	IIT Madras	10%	2 week
22		BTAPE405 B	Elective-I Alternative Fuels for IC	Fundamentals of Automotive Systems	IIT Madras	40%	12 week
				Alternate Fules and Advances In IC Engines	IIT, Kanpur	100%	6 week
				IC engine and gas turbine	IIT Guwahati	30%	12 week
23		BTMPE40 5B	Elective-I Numerical Methods in Engineering	Numerical Methods in Engineers	IIT Madras	50%	12 week
				Numerical Methods and simulation techniques for scientists and engineers	IIT Guwahati	70%	6 week
				Numerical Method and computation	IIT Delhi	60%	11 week
24		BTMPE40 5C	Elective-I Sheet Metal Engineering	Principles of Metal Forming Technology	IIT Roorkee	70%	10 week
				Fundamental concepts of metal forming technology	SASTRA University, Thanjavur	40%	10 week
25		BTMPE40 5D	Elective-I Fluid Machinery	Turbomacnines	DSCE, Bangaluru, Karnataka	60%	8 week
				Fluid Mechanics	IIT Kharagpur	60%	8 week
26	5th	BTPC501	Design of Machine Elements	1.Design of Machine Elements - I 2.Machine Design-II	IIT, Kharagpur, IIT Madras	60	1. 10 Weeks 2. 10 Weeks
27		BTAC502	Automotive Chassis, Suspension & Transmission Systems	Fundamentals of automotive systems	IIT Madras	60	12 Weeks
28		BTAC503	Manufacturing Processes	1.Fundamentals and Manufacturing 2.Processes, Manufacturing Processes-I	IIT Roorkee	60	1. 12 Weeks 2. 8 Weeks
29		BTAPE504 A	Automobile Design	No course available			
30		BTAPE504 B	Automobile Tribology	No course available			
31		BTAPE504 C	Engines Special Purpose Vehicles	No course available			
32		BTAPE504 D	Automobile Engineering	Fundamentals of automotive systems	IIT Madras	30	12 Weeks
33		BTMPE50 4A	Metrology and Quality Control	1.Introduction to metrology 2.Engineering Metrology 3.Statistical quality control in textile industry.	IIT Madras, IIT Kanpur, IIT Delhi	70	1. 10 Weeks 2. 12 Weeks 3. 8 Weeks
34		BTMOE50 5A	Solar Energy	Solar Energy Technology	IIT Kharagpur	60	12 Weeks
35		BTMOE50 5B	Renewable Energy Sources	1.Non Conventional Energy Resources 2.Technologies for clean and renewable energy production	IIT Madras, IIT Roorkee	60	1. 12 Weeks 2. 8 Weeks

36		BTMOE505C	Human Resource Management	Principles of Human Resource Management	IIT Kharagpur	30	8 Weeks
37		BTMOE505D	Product Design Engineering	Product design and development	IIT Roorkee	20	4 Weeks
38	6th	BTAC601	Automobile Air Conditioning, Electricals and Electronics	No course available			
39		BTAC602	Vehicle Dynamics, Emission and Control	1.Vehicle Dynamics 2.Engine Combustion	IIT Madras, IIT Kanpur	70	1. 8 Weeks 2. 10 Weeks
40		BTAPE603A	Vehicle Architecture and Packaging	Manufacturing systes technology part-I	IIT Kanpur	40	12 Weeks
41		BTAPE603B	Computer Simulation of IC Engine Processes	No course available			
42		BTAPE603C	Automobile Body Design (Pre-requisite: Automobile Design)	No course available			
43		BTAPE603D	Vehicle Aerodynamics	Introduction to Aerodynamics	IIT Kharagpur	20	12 Weeks
44		BTAPE603E	E Vehicles	Electric Vehicles Part-I	IIT Delhi	70	4 Weeks
45		BTAPE603F	Design of Experiments	No course available			
46		BTAPE604A	Transport Management	No course available			
47		BTAPE604B	Computational Fluid Dynamics	Computational Fluid Dynamics	IIT Kharagpur	40	12 Weeks
48		BTAPE604C	Ergonomics in Automotive Design	Ergonomics in Automotive Design	IIT Guwahati	70	4 Weeks
49		BTAPE604D	Tractor and Farm Equipment	No course available			
50		BTAPE604E	Noise and Vibration	1.Noise management and control 2.Vibration control	IIT Kanpur , IIT Roorkee	50	1. 12 Weeks 2. 10 Weeks
51		BTMPE604B	Product Life Cycle Management	Product design and development	IIT Roorkee	40	4 Weeks
52		BTMPE604C	Finite Element Method	1.Basic of finite element analysis- I 2.Basic of finite element analysis- II	IIT Kanpur	60	1. 8 Weeks 2. 8 Weeks
53		BTMPE604D	Robotics	Robotics	IIT Kharagpur	70	8 Weeks
54		BTMOE605A	Quantitative Techniques and Project Management	Operation research	IIT Roorkee	20	8 Weeks
55		BTMOE605B	Nanotechnology	1.Nanotechnology, science and applications 2.Nanostructure and Nanomaterials : Characterization and properties,	IIT Madras	50	1. 8 Weeks 2. 12 Weeks
56		BTMOE605C	Energy Conservation and Management	No course available			
57		BTMOE605D	Wind Energy	Non conventional energy resources	IIT Madras	50	12 Weeks
58		BTMOE605E	Introduction to Probability Theory and Statistics	No course available			
59	Semester VII	BTAC701	Vehicle Performance and Testing	Fundamentals of Automotive Systems	IIT Madras	20%	12 week
60		BTHM702	Industrial Engineering and Management	Principles of Industrial engineering	IIT Roorkee	40%	12 week

61		BTAPE703 A	Elective-V Design & Manfg. of Automotive Components	Theory and Design of Automotive Engines	PES college of Engineering, Karnataka	100%	8 week
62		BTAPE703 B	Elective-V Virtual Reality	Virtual Reality Engineering	IIT Madras	60%	12 week
63				Virtual Reality	University of Illinois, IIT Madras	60%	12 week
64		BTAPE703 C	Elective-V Actuation System				
65		BTAPE703 D	Elective-V Electric and Hybrid Vehicles	Introduction to Hybrid and Electric Vehicles	IIT Guwahati	80%	10 week
66		BTAPE703 E	Elective-V :Safety & Regulations (Automotive)				
67		BTAPE703 F	Elective-V Motor Insurance Practices				
68		BTMPE70 3B	Elective-V Biomechanics	Mechanics of human movement	IIT Madras	20%	12 week
69		BTMOE70 4A	Open Elective III: Sustainable Development	Introduction to environmental engineering and science-fundamental and sustainabiltiy concepts	IIT Kharagpur	40%	12 week
70		BTMOE70 4B	Open Elective III: Entrepreneurship Development	Entrepreneurship	IIT Madras	50%	12 week
				Entrepreneurship Essentials	IIT Kharagpur	20%	12 week
71		BTMOE70 4C	Open Elective III: Plant Maintenance				
72		BTMOE70 5A	Open Elective IV: Engineering Economics	Economics, Management and Entreprenerurship	IIT Kharagpur	60%	10 week
				Engineering Ecomonics Analysis	IIT Roorkee	60%	10 week
73		BTMOE70 5B	Open Elective IV: Biology for Engineers	Biology for engineers and other non-biologists	IIT Madras	100%	6 week
				Biology for engineers and other non-biologists	IIT Madras	100%	4 week
				Bioengineering	IIT Bombay	20%	
74		BTMOE70 5C	Open Elective IV: Intellectual Property Rights	Introduction to Intellectual Property to Engineers and Technologists	IIT Kharagpur	100%	8 week
				Intellectual Property Rights and Competition Law	IIT Kharagpur	50%	8 week
				Intellectual Property	IIT Madras	50%	11 week