VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

B.E. in Mechanical Engineering

Scheme of Teaching and Examinations2022

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023-24)

III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	SDA	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	PCC	BME301	Mechanics of Materials	TD- ME PSB-ME	2	2	0		03	50	50	100	3
2	IPCC	BME302	Manufacturing Process	TD: ME PSB: ME	3	0	2		03	50	50	100	4
3	IPCC	BME303	Material Science and Engineering	TD: ME PSB: ME	3	0	2		03	50	50	100	4
4	PCC	BME304	Basic Thermodynamics	TD: ME PSB: ME	2	2	0		03	50	50	100	3
5	PCCL	BMEL305	Introduction to Modelling and Design for Manufacturing	TD: ME PSB: ME	0	0	2		03	50	50	100	1
6	ESC	BME306x	ESC/ETC/PLC	TD: Respective Dept. PSB: Respective Dept.	3	0	0		03	50	50	100	3
7	UHV	BSCK307	**Social Connect and Responsibility**	Any Department	0	0	2		01	100	---	100	1
8	AEC/ SEC	BME358x	Ability Enhancement Course/Skill Enhancement Course - III		If the course is a Theory				01	50	50	100	1
					1	0	0						
					If a course is a laboratory				02				
					0	0	2						
9	MC	BNSK359	National Service Scheme (NSS)	NSS coordinator	0	0	2			100	---	100	0
		BPEK359	Physical Education (PE) (Sports and Athletics)	Physical Education Director									
		BYOK359	Yoga	Yoga Teacher									
									Total	**550**	**350**	**900**	**20**

PCC: Professional Core Course, **PCCL**: Professional Core Course laboratory, **UHV**: Universal Human Value Course, **MC**: Mandatory Course (Non-credit), **AEC**: Ability Enhancement Course, **SEC**: Skill Enhancement Course, **L:** Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation.K: This letter in the course code indicates common to all the stream of engineering. ESC: Engineering Science Course, ETC: Emerging Technology Course, PLC: Programming Language Course

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Engineering Science Course (ESC/ETC/PLC)[L-T-P::3-0-0]			
BME306A	Electric and Hybrid Vehicle Technology	BME306C	Internet of Things (IoT)
BME306B	Smart Materials & Systems	BME306D	Waste handling and Management
Ability Enhancement Course – III			
BME358A	Advanced Python Programming [0-0-2]	BME358C	Spreadsheet for Engineers [0-0-2]
BME358B	Introduction to Virtual Reality , [0-2-0]	BME358D	Tools in Scientific Computing [0-0-2]

Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practical's of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. For more details, the regulation governing the Degree of Bachelor of Engineering /Technology (B.E./B.Tech.) 2022-23 may please be referred.

National Service Scheme /Physical Education/Yoga: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE)(Sports and Athletics), and Yoga(YOG) with the concerned coordinator of the course during the first week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, and Yoga activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of degree.

VARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

B.E. in Mechanical Engineering

Scheme of Teaching and Examinations2022

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023-24)

IV SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Self -Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	PCC	BME401	Applied Thermodynamics	TD: ME PSB:ME	2	2	0		03	50	50	100	3
2	IPCC	BME402	Machining Science & Metrology	TD: ME PSB:ME	3	0	2		03	50	50	100	4
3	IPCC	BME403	Fluid Mechanics	TD: ME PSB:ME	3	0	2		03	50	50	100	4
4	PCCL	BME404	Mechanical Measurements and Metrology lab	TD: ME PSB:ME	0	0	2		03	50	50	100	1
5	ESC	BME405x	ESC/ETC/PLC	TD: Respective Dept. PSB: Respective Dept.	3	0	0		03	50	50	100	3
6	AEC/ SEC	BME456x	Ability Enhancement Course/Skill Enhancement Course- IV	TD and PSB: Concerned department	If the course is Theory				01	50	50	100	1
					1	0	0						
					If the course is a lab				02				
					0	0	2						
4	BSC	BBOK407	Biology For Engineers	TD / PSB: BT, CHE,	3	0	0		03	50	50	100	3
7	UHV	BUHK408	Universal human values course	Any Department	1	0	0		01	50	50	100	1
9	MC	BNSK459	National Service Scheme (NSS)	NSS coordinator	0	0	2			100	---	100	0
		BPEK459	Physical Education (PE) (Sports and Athletics)	Physical Education Director									
		BYOK459	Yoga	Yoga Teacher									
									Total	**500**	**400**	**900**	**20**

PCC: Professional Core Course, **PCCL**: Professional Core Course laboratory, **UHV**: Universal Human Value Course, **MC**: Mandatory Course (Non-credit), **AEC**: Ability

Enhancement Course, **SEC**: Skill Enhancement Course, **L:** Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. K :This letter in the course code indicates common to all the stream of engineering.			
Engineering Science Course (ESC/ETC/PLC) [L-T-P::3-0-0]			
BME405A	Non Traditional Machining	BME405C	Micro Electro Mechanical Systems
BME405B	Environmental Studies	BME405D	Robotics and Automation
Ability Enhancement Course / Skill Enhancement Course - IV			
BME456A	Introduction to AI & ML [0-0-2]	BME456C	Introduction to Data Analytics [0-0-2]
BME456B	Digital Marketing [0-2-0]	BME456D	Introduction to Programming in C++ [0-0-2]

Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practical of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. For more details, the regulation governing the Degree of Bachelor of Engineering /Technology (B.E./B.Tech.) 2022-23.

National Service Scheme /Physical Education/Yoga: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE)(Sports and Athletics), and Yoga(YOG) with the concerned coordinator of the course during the first week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, and Yoga activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the courses is mandatory for the award of degree.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

B.E. in Mechanical Engineering

Scheme of Teaching and Examinations2022

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023-24)

V SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Self -Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	HSMS	BME501	Industrial Management & Entrepreneurship	TD: ME PSB:ME	3	0	0		03	50	50	100	3
2	IPCC	BME502	Turbo machines	TD: ME PSB:ME	2	2	2		03	50	50	100	4
3	PCC	BME503	Theory of Machines	TD: ME PSB:ME	4	0	0		03	50	50	100	4
4	PCCL	BME504L	CNC Programming and 3-D Printing lab	TD: ME PSB:ME	0	0	2		03	50	50	100	1
5	PEC	BME515x	Professional Elective - I	TD: ME PSB:ME	3	0	0		03	50	50	100	3
6	PROJ	BME586	Mini Project	TD: ME PSB:ME	0	0	4		03	100		100	2
7	AEC	BRMK557	Research Methodology and IPR	Any Department	2	2	0		03	50	50	100	3
8	MC	BESK508	Environmental Studies	TD: CV/Env/Chem PSB:CV	2	0	0		02	50	50	100	2
9	MC	BNSK559	National Service Scheme (NSS)	NSS coordinator	0	0	2			100		100	0
		BPEK559	Physical Education (PE) (Sports and Athletics)	Physical Education Director									
		BYOK559	Yoga	Yoga Teacher									
									Total	**500**	**300**	**800**	**22**

Professional Elective Course

BME515A	Mechatronics	BME515C	Supply chain management & Introduction to SAP
BME515B	Automation in manufacturing	BME515D	Energy Engineering

PCC: Professional Core Course, **PCCL**: Professional Core Course laboratory, **UHV**: Universal Human Value Course, **MC**: Mandatory Course (Non-credit), **AEC**: Ability

Enhancement Course, **SEC**: Skill Enhancement Course, **L:** Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **K :** The letter in the course code indicates common to al the stream of engineering. **PROJ**: Project /Mini Project. **PEC**: Professional Elective Course

Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practical of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. For more details, the regulation governing the Degree of Bachelor of Engineering /Technology (B.E./B.Tech.) 2022-23

National Service Scheme /Physical Education/Yoga: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE)(Sports and Athletics), and Yoga(YOG) with the concerned coordinator of the course during the first week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, and Yoga activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of degree.

Mini-project work: Mini Project is a laboratory-oriented/hands on course that will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications etc. Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.

CIE procedure for Mini-project:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two faculty members of the Department, one of them being the Guide. The CIE marks awarded for the Mini-project work shall be based on the evaluation of the project report, project presentation skill, and question and answer session in the ratio of 50:25:25. The marks awarded for the project report shall be the same for all the batches mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all the guides of the project.

The CIE marks awarded for the Mini-project, shall be based on the evaluation of the project report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

No SEE component for Mini-Project.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering a professional elective is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

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B.E. in Mechanical Engineering

scheme of Teaching and Examinations2022

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023-24)

VI SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Self -Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	IPCC	BME601	Heat Transfer	TD: ME PSB:ME	2	2	2		03	50	50	100	4
2	PCC	BME602	Machine Design	TD: ME PSB:ME	3	2	0		03	50	50	100	4
3	PEC	BME613x	Professional Elective - II	TD: ME PSB:ME	3	0	0		03	50	50	100	3
4	OEC	BME654x	Open Elective -I	TD: ME PSB:ME	3	0	0		03	50	50	100	3
5	PROJ	BME685	Major Project Phase - I	TD: ME PSB:ME	0	0	4		03	100	--	100	2
6	PCCL	BMEL606L	Design lab	TD: ME PSB:ME	0	0	2		03	50	50	100	1
7	AEC/SDC	BME657x	Ability Enhancement Course/Skill Development Course V		If the course is offered as a Theory: 1	0	0		01	50	50	100	1
					If course is offered as a practical: 0	0	2						
8	MC	BNSK658	National Service Scheme (NSS)	NSS coordinator	0	0	2			100	---	100	0
		BPEK658	Physical Education (PE) (Sports and Athletics)	Physical Education Director									
		BYOK658	Yoga	Yoga Teacher									
9	IKS	BIKS609	Indian Knowledge System		1	0	0		01	100	0	100	0
									Total	**500**	**300**	**800**	**18**

Professional Elective Course

BME613A	Total Quality Management	BME613C	MEMS and Microsystem Technology

BME613B	Refrigeration and Air Conditioning	BME613D	Design for Manufacturing and Assembly
Open Elective Course			
BME654A	Project Management	BME654C	Introduction to Mechatronics
BME654B	Renewable Energy Power plants	BME654D	Modern Mobility
Ability Enhancement Course / Skill Enhancement Course-V			
BME657A	Basics of Matlab [0-0-2]	BME657C	Simulation and Analysis using Ansys workbench [0-0-2]
BME657B	Fundamental of Virtual Reality ARP Development	BME657D	Introduction Augmented Reality

PCC: Professional Core Course, **PCCL**: Professional Core Course laboratory, **UHV**: Universal Human Value Course, **MC**: Mandatory Course (Non-credit), **AEC**: Ability Enhancement Course, **SEC**: Skill Enhancement Course, **L:** Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **K :** The letter in the course code indicates common to al the stream of engineering. **PROJ**: Project /Mini Project. **PEC**: Professional Elective Course. **PROJ**: Project Phase -I, **OEC**: Open Elective Course

Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practical of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. For more details, the regulation governing the Degree of Bachelor of Engineering /Technology (B.E./B.Tech.) 2022-23

National Service Scheme /Physical Education/Yoga: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE)(Sports and Athletics), and Yoga(YOG) with the concerned coordinator of the course during the first week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, and Yoga activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of degree.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering professional electives is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

Open Elective Courses:

Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor. The minimum numbers of students' strength for offering Open Elective Course is 10. However, this condition shall not be applicable to class where the admission to the program is less than 10.

Project Phase-I : Students have to discuss with the mentor /guide and with their help he/she has to complete the literature survey and prepare the report and finally define the problem statement for the project work.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

B.E. in Mechanical Engineering

Scheme of Teaching and Examinations2022

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023-24)

Scheme A- VIISEMESTER (Swappable VII and VIII SEMESTER)

Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Self -Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	IPCC	BME701	Finite Element Methods	TD: ME PSB:ME	3	0	2		03	50	50	100	4
2	IPCC	BME702	Hydraulics and Pneumatics	TD: ME PSB:ME	3	0	2		03	50	50	100	4
3	PCC	BME703	Control Engineering	TD: ME PSB:ME	4	0	0		03	50	50	100	4
4	PEC	BME714x	**Professional Elective-III**	TD: ME PSB:ME	3	0	0		03	50	50	100	3
5	OEC	BME755x	**Open Elective- II**	TD: ME PSB:ME	3	0	0		01	50	50	100	3
6	PROJ	BME786	**Major Project Phase-II**		0	0	12		03	100	100	200	6
										400	**300**	**700**	**24**

Professional Elective Course

BME714A	Additive manufacturing	BME714C	IC Engines
BME714B	Product Design and Management	BME714D	Cryogenics

Open Elective Course

BME755A	Introduction to Non-Traditional machining	BME755C	Operations Research
BME755B	Basics of Hydraulics and Pneumatics	BME755D	Non-Conventional Energy Resources

PCC: Professional Core Course, **PCCL**: Professional Core Course laboratory, **PEC**: Professional Elective Course, **OEC**: Open Elective Course PR: Project Work, **L:** Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **TD-** Teaching Department, **PSB**: Paper Setting department, **OEC**: Open Elective Course, **PEC**: Professional Elective Course. **PROJ**: Project work

Note: VII and VIII semesters of IV years of the program

(1) Institutions can swap the VII and VIII Semester Schemes of Teaching and Examinations to accommodate research internships/ industry internships after the VI

semester**.**

(2) Credits earned for the courses of VII and VIII Semester Scheme of Teaching and Examinations shall be counted against the corresponding semesters whether the VII or VIII semesters is completed during the beginning of the IV year or the later part of IV years of the program.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering professional electives is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

Open Elective Courses:

Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor. The minimum numbers of students' strength for offering Open Elective Course is 10. However, this condition shall not be applicable to class where the admission to the program is less than 10.

PROJECT WORK (21MEP75): The objective of the Project work is

(i) To encourage independent learning and the innovative attitude of the students.

(ii) To develop interactive attitude, communication skills, organization, time management, and presentation skills.

(iii) To impart flexibility and adaptability.

(iv) To inspire team working.

(v) To expand intellectual capacity, credibility, judgment and intuition.

(vi) To adhere to punctuality, setting and meeting deadlines.

(vii) To install responsibilities to oneself and others.

(viii) To train students to present the topic of project work in a seminar without any fear, face the audience confidently, enhance communication skills, involve in group discussion to present and exchange ideas.

CIE procedure for Project Work:

(1) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work, shall be based on the evaluation of the project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

(2) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work, shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

SEE procedure for Project Work: SEE for project work will be conducted by the two examiners appointed by the University. The SEE marks awarded for the project work shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25.

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Scheme A- VIIISEMESTER (Swappable VII and VIII SEMESTER)

Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Self -Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	PEC	BME801x	**Professional Elective -IV (Online Courses)**	TD: ME PSB:ME	3	0	0		03	50	50	100	3
2	OEC	BME802x	**Open Elective - III (Online Courses)**	TD: ME PSB:ME	3	0	0		03	50	50	100	3
3	INT	BME803	**Internship (Industry/Research) (14 - 20 weeks)**	TD: ME	0	0	12		03	100	100	200	10
										200	**200**	**400**	**16**

Professional Elective Course (Online courses)

BME801A	Quality Design & Control (Available in NPTEL)	BME801C	Modelling & Analytics for Supply Chain Management (Available in NPTEL)
BME801B	Machinery Fault Diagnosis and Signal Processing (Available in NPTEL)	BME801D	Strategies for Sustainable Design (Available in NPTEL)

Open Elective Courses (Online Courses)

BME802A	Fundamentals of Automotive systems (Available in NPTEL)	BME802C	Computer Integrated Manufacturing (Available in NPTEL)
BME802B	Product Design and Manufacturing (Available in NPTEL)	BME802D	Business Planning & Project Management (Available in Swayam Portal)

L: Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **TD-** Teaching Department, **PSB**: Paper Setting department, **OEC**: Open Elective Course, **PEC**: Professional Elective Course. **PROJ**: Project work, **INT**: Industry Internship / Research Internship / Rural Internship

Note: VII and VIII semesters of IV years of the program

Swapping Facility

- Institutions can swap VII and VIII Semester Scheme of Teaching and Examinations to accommodate **research internships/ industry internships/Rural Internship** after the VI semester**.**

- Credits earned for the courses of VII and VIII Semester Scheme of Teaching and Examinations shall be counted against the corresponding semesters whether VII or VIII semester is completed during the beginning of IV year or later part of IV year of the program.

Elucidation:

At the beginning of IV years of the program i.e., after VI semester, VII semester classwork and VIII semester **Research Internship /Industrial Internship / Rural Internship** shall be permitted to be operated simultaneously by the University so that students have ample opportunity for an internship. In other words, a good percentage of the class shall attend VII semester classwork and a similar percentage of others shall attend to Research Internship or Industrial Internship or Rural Internship.

Research/Industrial /Rural Internship shall be carried out at an Industry, NGO, MSME, Innovation centre, Incubation centre, Start-up, centre of Excellence (CoE), Study Centre established in the parent institute and /or at reputed research organizations/institutes.

The mandatory Research internship /Industry internship / Rural Internship is for 14 to 20 weeks. The internship shall be considered as a head of passing and shall be considered for the award of a degree. Those, who do not take up/complete the internship shall be declared to fail and shall have to complete it during the subsequent University examination after satisfying the internship requirements.

Research internship: A research internship is intended to offer the flavour of current research going on in the research field. It helps students get familiarized with the field and imparts the skill required for carrying out research.

Industry internship: Is an extended period of work experience undertaken by students to supplement their degree for professional development. It also helps them learn to overcome unexpected obstacles and successfully navigate organizations, perspectives, and cultures. Dealing with contingencies helps students recognize, appreciate, and adapt to organizational realities by tempering their knowledge with practical constraints.

Rural Internship: Rural development internship is an initiative of Unnat Bharat Abhiyan Cell, RGIT in association with AICTE to involve students of all departments studying in different academic years for exploring various opportunities in techno-social fields, to connect and work with Rural India for their upliftment.

The faculty coordinator or mentor has to monitor the student's internship progress and interact with them to guide for the successful completion of the internship.

The students are permitted to carry out the internship anywhere in India or abroad. University shall not bear any expenses incurred in respect of the internship.

With the consent of the internal guide and Principal of the Institution, students shall be allowed to carry out the internship at their hometown (**within or outside the state or abroad**), provided favorable facilities are available for the internship and the student remains regularly in contact with the internal guide. **University shall not bear any cost involved in carrying out the internship by students.** However, students can receive any financial assistance extended by the organization.

Professional Elective /Open Elective Course: These are ONLINE courses suggested by the respective Board of Studies. Details of these courses shall be made available for students on the VTU web portal.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

B.E. in the title of the program

Scheme of Teaching and Examinations2022

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023-24)

Scheme B-VI SEMESTER for the candidates who seek a two-semester internship with project work /Start-up

Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	SDA	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	IPCC	BXX601	Heat Transfer		3	0	2		03	50	50	100	4
2	PCC	BXX602	Machine Design		4	0	0		03	50	50	100	4
3	PEC	BXX613x	Professional Elective Course		3	0	0		03	50	50	100	3
4	OEC	BXX654x	Open Elective Course		3	0	0		03	50	50	100	3
5	PCCL	BXXL606	Machine Design Lab		0	0	2		03	50	50	100	1
6	AEC/SDC	BXX657x	Ability Enhancement Course/Skill Development Course V		If the course is offered as a Theory: 1	0	0		01	50	50	100	1
					If course is offered as a practical: 0	0	2						
7	MC	BNSK658	National Service Scheme (NSS)	NSS coordinator	0	0	2			100	---	100	0
		BPEK658	Physical Education (PE) (Sports and Athletics)	Physical Education Director									
		BYOK658	Yoga	Yoga Teacher									
8	IKS	BIKS609	Indian Knowledge System		1	0	0		01	100	0	100	0
									Total	**500**	**300**	**800**	**16**

Professional Elective Course			
BME613A	Total Quality Management	BME613C	MEMS and Microsystem Technology
BME613B	Refrigeration and Air Conditioning	BME613D	Design for Manufacturing and Assembly
Open Elective Course			
BME654A	Project Management	BME654C	Introduction to Mechatronics

BME654B	Renewable Energy Power plants	BME654D	Modern Mobility
Ability Enhancement Course / Skill Enhancement Course-V			
BME657A	Basics of Matlab [0-0-2]	BME657C	Simulation and Analysis using Ansys workbench [0-0-2]
BME657B	Fundamental of Virtual Reality ARP Development	BME657D	Introduction Augmented Reality

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

B.E. in the title of the program

Scheme of Teaching and Examinations2022

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023-24)

Scheme BVII and VIII semesters for the candidateswho seek an internship with project work

Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	SDA	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	IPCC	BXX701	**To be completed in 5th/6th semester**		3	0	2		03	50	50	100	4
2	IPCC	BXX702	**To be completed in 5th /6th semester**		3	0	2		03	50	50	100	4
3	PCC	BXX703	**To be completed in the 6th semester**		4	0	0		03	50	50	100	3
4	PEC	BXX714x	**Professional Elective Course (MOOC Courses)**		3	0	0		03	50	50	100	3
5	OEC	BXX755x	**Open Elective Courses (MOOC courses)**		3	0	0		01	50	50	100	3
1	PEC	Bxx801x	**Professional Elective (MOOC Courses)**		3	0	0		03	50	50	100	3
2	OEC	Bxx802x	**Open Elective (MOOC Courses)**		3	0	0		01	50	50	100	3
3	PROJ	BXX883	**Project - outcome of training**		0	0	12		03	100	100	200	9
4	INT	Bxx804	**Internship (Industry/Research) (02 semesters)**		0	0	12		03	100	100	200	10
										200	**200**	**400**	**42**

MECHANICS OF MATERIALS		Semester	03
Course Code	**BME301**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	**2:2:0:0**	SEE Marks	50
Total Hours of Pedagogy	**40**	Total Marks	100
Credits	**03**	Exam Hours	3 hrs
Examination type (SEE)	**Theory**		

Course objectives:

- To provide the basic concepts and principles of strength of materials.
- To give an ability to calculate stresses and deformations of objects under external loadings.
- To give an ability to apply the knowledge of strength of materials on engineering applications and design problems.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Videodemonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such asevaluating, generalizing, and analyzing information.

Module-1

Simple stress and strain: Definition/derivation of normal stress, shear stress, and normal strain and shear strain – Stress strain diagram for brittle and ductile materials - Poisson's ratio & volumetric strain – Elastic constants – relationship between elastic constants and Poisson's ratio – Generalised Hook's law – Deformation of simple and compound bars, Resilience, Gradual, sudden, impact and shock loadings – thermal stresses.

Module-2

Bi-axial Stress system: Introduction, plane stress, stresses on inclined sections, principal stresses and maximum shear stresses, graphical method - Mohr's circle for plane stress.

Thick and Thin cylinders: Stresses in thin cylinders, Lame's equation for thick cylinders subjected to internal and external pressures, Changes in dimensions of cylinder (diameter, length and volume), simple numerical.

Module-3

Bending moment and Shear forces in beams: Definition of beam – Types of beams – Concept of shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, uniformly distributed loads, uniformly varying loads and combination of these loads – Point of contra flexure.

Module-4

Theory of simple bending – Assumptions – Derivation of bending equation - Neutral axis – Determination of bending stresses – section modulus of rectangular and circular sections (Solid and Hollow), I, T and Channel sections – Design of simple beam sections, Shear Stresses: Derivation of formula – Shear stress distribution across various beams sections like rectangular, circular, triangular, I, and T sections.

Module-5

Torsion of circular shafts: Introduction, pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts, power transmitted by solid and hollow circular shafts.

Theory of columns – Long column and short column - Euler's formula – Rankine's formula.

Course outcome (Course Skill Set)

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

CO1: Understand the concepts of stress and strain in simple and compound bars.

CO2: Explain the importance of principal stresses and principal planes & Analyse cylindrical pressure vessels under various loadings

CO3: Apply the knowledge to understand the load transferring mechanism in beams and stress distribution due to shearing force and bending moment.

CO4: Evaluate stresses induced in different cross-sectional members subjected to shear loads.

CO5: Apply basic equation of simple torsion in designing of circular shafts & Columns

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks.

Suggested Learning Resources:

Books

1. Mechanics of Materials, S.I. Units, Ferdinand Beer & Russell Johnstan, 7th Ed, TATA McGrawHill-2014
2. Mechanics of Materials, K.V.Rao, G.C.Raju, Subhash Stores, First Edition, 2007
3. Strength of Materials by R.K. Bansal ,Laxmi Publications 2010.

Web links and Video Lectures (e-Resources):

1. Statics and Strength of Materials, Shehata, 2nd edition, 1994. (http://www.astm.org/DIGITAL_LIBRARY/JOURNALS/TESTEVAL/PAGES/JTE12637J. htm)
2. http://www.astm.org/DIGITAL_LIBRARY/JOURNALS/TESTEVAL/PAGE S/JTE12637J.htm
3. 3. http://www.freeengineeringbooks.com/Civil/Strength-of-MaterialBooks.php

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Use Mdsolids (https://web.mst.edu/mdsolids/) or any open source software for active teaching and learning.

MANUFACTURING PROCESS		Semester	III
Course Code	**BME302**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
Examination nature (SEE)	Theory /Viva-Voce /Term-work/Others		

Course objectives:

- To provide knowledge of various casting process in manufacturing.
- To provide in-depth knowledge on metallurgical aspects during solidification of metal and alloys, also to provide detailed information about the moulding processes.
- To acquaint with the basic knowledge on fundamentals of metal forming processes and also to study various metal forming processes.
- To impart knowledge of various joining process used in manufacturing.
- To impart knowledge about behaviour of materials during welding, and the effect of process
- parameters in welding

Teaching-Learning Process (General Instructions)

These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby power plants, receiving station and substations to give brief information about the electrical power generation.
3. Show Video/animation films to explain functioning of various machines
4. Encourage collaborative (Group Learning) Learning in the class
5. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
6. Adopt Problem Based Learning (PBL), which fosters students Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

MODULE-1

Introduction & basic materials used in foundry: *Introduction: Definition, Classification of manufacturing processes. Metals cast in the foundry-classification, factors that determine the selection of a casting alloy. Introduction to casting process & steps involved – (Brief Introduction)- Not for SEE*

Patterns: Definition, classification, materials used for pattern, various pattern allowances and their importance.

Sand moulding: Types of base sand, requirement of base sand. Binder, Additive's definition, need and types; preparation of sand moulds. Molding machines- Jolt type, squeeze type and Sand slinger.

Study of important moulding process: Green sand, core sand, dry sand, sweep mould, CO2mould, shell mould, investment mould, plaster mould, cement bonded mould.

Cores: Definition, need, types. Method of making cores,

Concept of gating (top, bottom, parting line, horn gate) and risers (open, blind) Functions and types.
MODULE-2
Melting furnaces: Classification of furnaces, Gas fired pit furnace, Resistance furnace, Coreless induction furnace, electric arc furnace, constructional features & working principle of cupola furnace. **Casting using metal moulds**: Gravity die casting, pressure die casting, centrifugal casting, squeeze casting, slush casting, thixocasting, and continuous casting processes. Casting defects, their causes and remedies.
MODULE-3
METAL FORMING PROCESSES ***Introduction of metal forming process****:* Mechanical behaviour of metals in elastic and plastic deformation, stress-strain relationships, Yield criteria, Application to tensile testing, train rate and temperature in metal working; Hot deformation, Cold working and annealing. ***Metal Working Processes****:* Fundamentals of metal working, Analysis of bulk forming processes like forging, rolling, extrusion, wire drawing by slab method, ***Other sheet metal processes****:* Sheet metal forming processes (Die and punch assembly, Blanking, piercing, bending etc., Compound and Progressive die), High Energy rate forming processes.
MODULE-4
JOINING PROCESSES ***Operating principle, basic equipment, merits and applications of***: Fusion welding processes: Gas welding - Types – Flame characteristics; Manual metal arc welding – Gas Tungsten arc welding - Gas metal arc welding – Submerged arc welding
MODULE-5
Weldability and thermal aspects: Concept of weldability of materials; Thermal Effects in Welding (Distortion, shrinkage and residual stresses in welded structures); Welding defects and remedies. ***Allied processes***: Soldering, Brazing and adhesive bonding **Advance welding processes:** Resistance welding processes, friction stir welding (FSW).

PRACTICAL COMPONENT OF IPCC

Course objectives:

- Impart fundamental understanding of various casting, welding and forming processes
- To provide in-depth knowledge on metallurgical aspects during solidification of metal and alloys
- Discuss design methodology and process parameters involve in obtaining defect free component

PRACTICAL COMPONENT OF IPCC *(May cover all / major modules)*

Sl.NO	Experiments
1	Preparation of sand specimens and conduction of the following tests: Compression, Shear and Tensile tests on Universal Sand Testing Machine.
2	To determine permeability number of green sand, core sand and raw sand.
3	To determine AFS fineness no. and distribution coefficient of given sand sample.
4	Studying the effect of the clay and moisture content on sand mould properties
5	Use of Arc welding tools and welding equipment Preparation of welded joints using Arc Welding equipment L-Joint, T-Joint, Butt joint, V-Joint, Lap joints on M.S. flats
6	Foundry Practice: Use of foundry tools and other equipment for Preparation of molding sand mixture. Preparation of green sand molds kept ready for pouring in the following cases: 1. Using two molding boxes (hand cut molds). 2. Using patterns (Single piece pattern and Split pattern).
7	Preparation of green sand molds kept ready for pouring in the following cases: 1. Incorporating core in the mold.(Core boxes).
8	Forging Operations: Use of forging tools and other forging equipment. Preparing minimum three forged models involving upsetting, drawing and bending operations.
Demo experiments for CIE	
9	Demonstration of forging model using Power Hammer.
10	To study the defects of Cast and Welded components using Non-destructive tests like: a) Ultrasonic flaw detection b) Magnetic crack detection c) Dye penetration testing
11	Mould preparation of varieties of patterns, including demonstration
12	Demonstration of material flow and solidification simulation using Auto-Cast software

Course outcomes (Course Skill Set):

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

CO1: Describe the casting process and prepare different types of cast products. Acquire knowledge on Pattern, Core, Gating, Riser system and to use Jolt, Squeeze, and Sand Slinger Moulding machines.

CO2: Compare the Gas fired pit, Resistance, Coreless, Electrical and Cupola Metal Furnaces. Compare the Gravity, Pressure die, Centrifugal, Squeeze, slush and Continuous Metal mold castings.

CO3: Understand the Solidification process and Casting of Non-Ferrous Metals.

CO4: Describe the Metal Arc, TIG, MIG, Submerged and Atomic Hydrogen Welding processes etc. used in manufacturing.

CO5: Describe the methods of different joining processes and thermal effects in joining process

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**)

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored by the student shall be proportionally scaled down to 50 Marks

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper may include questions from the practical component.

Suggested Learning Resources:

Books

1. Ghosh, A. and Mallik, A. K., (2017), Manufacturing Science, East-West Press.
2. Parmar R. S., (2007), Welding Processes and Technology, Khanna Publishers.
3. Little R. L. – 'Welding and Welding Technology' – Tata McGraw Hill Publishing Company Limited, New Delhi – 1989
4. Grong O. – 'Metallurgical Modelling of Welding' – The Institute of Materials – 1997 – 2nd Edition
5. Kou S. – 'Welding Metallurgy' – John Wiley Publications, New York – 2003 – 2nd Edition.

6. Serope Kalpakjian and Steven R. Schmid – 'Manufacturing Engineering and Technology' – Prentice Hall – 2013 – 7th Edition
7. Principles of foundry technology, 4th edition, P L Jain, Tata McGraw Hill, 2006.
8. Advanced Welding Processes technology and process control, John Norrish, Wood Head Publishing, 2006.

Web links and Video Lectures (e-Resources):

- (Link:http://www.springer.com/us/book/9781447151784http://nptel.ac.in/courses/112
- 105127/)
- http://www.astm.org/DIGITAL_LIBRARY/MNL/SOURCE_PAGES/MNL11.htm
- http://www.astm.org/DIGITAL_LIBRARY/JOURNALS/COMPTECH/PAGES/CTR10654J.htm
- MOOCs: http://nptel.ac.in/courses/112105126/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

Metal Casting: Design pattern/core for a given component drawing and develop a sand mould with optimum gating and riser system for ferrous and non-ferrous materials. Melting and casting, inspection for macroscopic casting defects.

- Welding: TIG and MIG welding processes – design weld joints – welding practice –weld quality inspection.
- Metal Forming: Press working operation – hydraulic and mechanical press -load calculation: blanking, bending and drawing operations – sheet metal layout design.

MATERIAL SCIENCE AND ENGINEERING		Semester	III
Course Code	**BME303**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	3
Examination nature (SEE)	**Theory**		

Course objectives:

- Explain the basic concepts of geometrical crystallography, crystal structure and imperfections in Solids.
- Construct the phase diagrams to know the phase transformations and concept of diffusion in solids.
- Identify the heat treatment, cooling method for controlling the microstructure and plastic deformation to modify their properties.
- Explain the powder metallurgy process, types and surface modifications.
- Apply the method of materials selection, material data, properties and knowledge sources for computer-aided selection of materials.

Teaching-Learning Process (General Instructions)

These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Videodemonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such asevaluating, generalizing, and analysing information.

MODULE-1

Structure of Materials

Introduction: Classification of materials, crystalline and non-crystalline solids, atomic bonding: Ionic Bonding and Metallic bonding.

Crystal Structure: Crystal Lattice, Unit Cell, Planes and directions in a lattice, Planar Atomic Density, Coordination number, atomic Packing Factor of all the Cubic structures and Hexa Close Packed structure. Classification and Coordination of voids, Bragg's Law.

Imperfections in Solids: Types of imperfections, Point defects: vacancies, interstitials, line defects, 2-D and 3D-defects, Concept of free volume in amorphous solids. Slip, Twinning.

MODULE-2

Physical Metallurgy

Alloy Systems: Classification of Solid solutions, Hume- Rothery Rules

Diffusion: Diffusion Mechanisms: Vacancy Diffusion and Interstitial Diffusion, Fick's laws of diffusion, Factors affecting diffusion.

Phase Diagrams: Gibbs Phase Rule, Solubility limit, phase equilibrium and Phase Diagrams: Isomorphous systems, Invariant Binary Reactions: Eutectic reaction, Eutectoid reaction and Peritectic reaction, Lever Rule, Iron-Carbon Diagram. Effect of common alloying elements in steel. Numerical on Lever rule.

MODULE-3

Nucleation and growth: Introduction to homogeneous and heterogeneous nucleation, critical radius for nucleation.

Heat treatment: Annealing, Normalizing, hardening, Tempering, Nitriding, Cyaniding, Induction Hardening and Flame Hardening, Recent advances in heat treat technology. TTT diagram, Recovery-Recrystallization-Grain Growth. Strengthening mechanisms: Strain hardening, Precipitation hardening (Solid-Solution Strengthening), Grain refinement.

MODULE-4
Surface coating technologies: Introduction, coating materials, coating technologies, types of coating: Electro-plating, Chemical Vapor Deposition(CVD), Physical Vapor Deposition(PVD), High Velocity Oxy-Fuel Coating, advantages and disadvantages of surface coating. **Powder metallurgy:** Introduction, Powder Production Techniques: Different Mechanical methods: Chopping or Cutting, Abrasion methods, Machining methods, Ball Milling and Chemical method: Chemical reduction method. **Characterization of powders (Particle Size & Shape Distribution), Powder Shaping:** Particle Packing Modifications, Lubricants & Binders, Powder Compaction & Process, Sintering and Application of Powder Metallurgy.
MODULE-5
Engineering Materials and Their Properties: Classification, **Ferrous materials:** Properties, Compositions and uses of Grey cast iron and steel. **Non-Ferrous materials:** Properties, Compositions and uses of Copper, Brass, Bronze. **Composite materials** - Definition, classification, types of matrix materials & reinforcements, Metal Matrix Composites (MMCs), Ceramic Matrix Composites (CMCs) and Polymer Matrix Composites (PMCs), Particulate-reinforced and fiber- reinforced composites, Applications of composite materials. Mechanical and functional properties of Engineering Materials **The Design Process and Materials Data:** Types of design, design tools and materials data, processes of obtainingmaterials data, materials databases. **Material Selection Charts:** Selection criteria for materials, material property Charts, deriving property limits and material indices.

PRACTICAL COMPONENT OF IPCC*(May cover all / major modules)*

Sl.NO	Experiments
1	Specimen preparation for macro and micro structural examinations and study the macrostructure and microstructure of a sample metal/ alloys.
2	Study the heat treatment processes (Hardening and tempering) of steel/Aluminium specimens.
3	To determine the hardness values of Mild Steel/ Aluminium by Rockwell hardness/Vickers Hardness.
4	To determine the hardness values of Copper/ Brass by Brinell's Hardness testing machine.
5	To determine the tensile strength, modulus of elasticity, yield stress, % of elongation and % of reduction in area of Cast Iron, Mild Steel/Brass/ Aluminium and to observe the necking.
6	To conduct a wear test on Mild steel/ Cast Iron/Aluminium/ Copper to find the volumetric wear rate and coefficient of friction.
7	To determine the Impact strength of the mild steel using Izod test and Charpy test.
8	Study the chemical corrosion and its protection. ***Demonstration***
9	Study the properties of various types of plastics. ***Demonstration***
10	Computer Aided Selection of Materials: Application of GRANTA Edupack for material selection: Case studies based on material properties. ***Demonstration***

Course outcomes (Course Skill Set):

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

1. Understand the atomic arrangement in crystalline materials and describe the periodic arrangement of atoms in terms of unit cell parameters.
2. Understand the importance of phase diagrams and the phase transformations.
3. Explain various heat treatment methods for controlling the microstructure..

4. Correlate between material properties with component design and identify various kinds of defects.
5. Apply the method of materials selection, material data and knowledge sources for computer-aided selection of materials.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**)

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scoredby the student shall be proportionally scaled down to 50 Marks

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper may include questions from the practical component.

Suggested Learning Resources:

Text Books:

1. Callister Jr, W.D., Rethwisch, D.G., (2018), Materials Science and Engineering: An Introduction, 10th Edition, Hoboken, NJ: Wiley.
2. Ashby, M.F. (2010), Materials Selection in Mechanical Design, 4th Edition, Butterworth- Heinemann.
3. Azaroff, L.V., (2001) Introduction to solids, 1st Edition, McGraw Hill Book Company.
4. Avner, S.H., (2017), Introduction to Physical Metallurgy, 2nd Edition, McGraw Hill Education.

Reference Books

1. Jones, D.R.H., and Ashby,M.F., (2011), Engineering Materials 1: An Introduction to Properties, Application and Design, 4th Edition, Butterworth-Heinemann.
2. Jones, D.R.H., and Ashby,M.F., (2012), Engineering Materials 2: An Introduction to Microstructure and Processing, 4th Edition, Butterworth-Heinemann.
3. Abbaschian, R., Abbaschian, L., Reed-Hill, R. E., (2009), Physical Metallurgy Principles, 4th Edition, Cengate Learning.
4. P. C. Angelo and R. Subramanian: Powder Metallurgy- Science, Technology and Applications, PHI, New Delhi,2008.

Web links and Video Lectures (e-Resources):

Web links and Video Lectures (e-Resources):

1. Bhattacharya,B., Materials Selection and Design, NPTEL Course Material, Department of Mechanical Engineering, Indian Institute of Technology Kanpur, http://nptel.ac.in/courses/112104122/
2. Prasad, R., Introduction to Materials Science and Engineering, NPTEL Course Material, Department of Materials

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

Course seminar

Industrial tour/Visit to Advanced Research Centres

BASIC THERMODYNAMICS		Semester	**3rd**
Course Code	**BME304**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	**2:2:0:0**	SEE Marks	50
Total Hours of Pedagogy	**40**	Total Marks	100
Credits	**03**	Exam Hours	03
Examination type (SEE)	**Theory**		

Course Objectives:

- Learn about thermodynamic system and its equilibrium, basic law of zeroth law of thermodynamics.
- Understand various forms of energy - heat transfer and work, Study the first law of thermodynamics.
- Study the second law of thermodynamics.
- Interpret the behaviour of pure substances and its application in practical problems.
- Study of Ideal and real gases and evaluation of thermodynamic properties.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Adopt flipped classroom teaching method.
4. Adopt collaborative (Group Learning) learning in the class
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1

Introduction and Review of fundamental concepts: Thermodynamic definition and scope, Microscopic and Macroscopic approaches. Characteristics of system boundary and control surface, examples. Thermodynamic properties; definition and units, intensive, extensive properties, specific properties, pressure, specific volume, Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic; processes; Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium ***(The topics are Only for Self-study and not to be asked in SEE. However, may be asked for CIE)***

Zeroth law of thermodynamics, Temperature; concepts, scales, international fixed points and measurement of temperature. Constant volume gas thermometer, constant pressure gas thermometer, mercury in glass thermometer, thermocouples, electrical resistance thermometer. Numerical.

Work and Heat: Mechanics, definition of work and its limitations. Thermodynamic definition of work; examples, sign convention. Displacement work; as a part of a system boundary, as a whole of a system boundary, expressions for displacement work in various processes through p-v diagrams. Shaft work; Electrical work. Other types of work. Heat; definition, units and sign convention. Problems.

Module-2

First Law of Thermodynamics: Joules experiments, equivalence of heat and work. Statement of the First law of thermodynamics, extension of the First law to non - cyclic processes, energy, energy as a property, modes of energy, Problems.

Extension of the First law to control volume; steady flow energy equation (SFEE), Problems.

Module-3

Second Law of Thermodynamics: Limitations of first law of thermodynamics, Thermal reservoir, heat engine and heat pump: Schematic representation, efficiency and COP. Reversed heat engine. Kelvin - Planck statement of the Second law of Thermodynamics; PMM I and PMM II, Clausius statement of Second law of Thermodynamics, Equivalence of the two statements; Carnot cycle, Carnot principles. Problems

Entropy: Clausius inequality, Statement- proof, Entropy- definition, a property, change of entropy, entropy as a quantitative test for irreversibility, principle of increase in entropy, entropy as a coordinate. Problems

Module-4

Availability, Irreversibility and General Thermodynamic relations. Introduction**,** Availability (Exergy), Unavailable energy, Relation between increase in unavailable energy and increase in entropy. Maximum work, maximum useful work for a system and control volume, irreversibility. Problems

Pure Substances: P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, saturated liquid, mixture of saturated liquid and vapor, saturated vapor and superheated vapor states of pure substance with water as example. Enthalpy of change of phase (Latent heat). Dryness fraction (quality), T-S and H-S diagrams, representation of various processes on these diagrams. Steam tables and its use. Throttling calorimeter, separating and throttling calorimeter. Problems.

Module-5

Ideal gases: Ideal gas mixtures, Daltons law of partial pressures, Amagat's law of additive volumes, evaluation of properties of perfect and ideal gases, Air- Water mixtures and related properties (*Processes are not to be asked for SEE*).

Real gases – Introduction, Van-der Waal's Equation of state, Van-der Waal's constants in terms of critical properties, Beattie-Bridgeman equation, Law of corresponding states, compressibility factor; compressibility chart. Difference between Ideal and real gases.

Thermodynamic relations: Maxwell's equations, TdS equation. Ratio of Heat capacities and Energy equation, Joule-Kelvin effect, Clausius-Clapeyron equation.

Course outcome (Course Skill Set)

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

CO1: Explain fundamentals of thermodynamics and evaluate energy interactions across the boundary of thermodynamic systems.

CO2: Apply 1st law of thermodynamics to closed and open systems and determine quantity of energy transfers.

CO3: Evaluate the feasibility of cyclic and non-cyclic processes using 2nd law of thermodynamics

CO4: Apply the knowledge of entropy, reversibility and irreversibility to solve numerical problems and Interpret the behaviour of pure substances and its application in practical problems.

CO5: Recognize differences between ideal and real gases and evaluate thermodynamic properties of ideal and real gas mixtures using various relations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation (CIE):

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Basic and Applied Thermodynamics P.K.Nag, Tata McGraw Hill 2nd Ed., 2002.
2. Basic Engineering Thermodynamics A.Venkatesh Universities Press, 2008.
3. Basic Thermodynamics, B.K Venkanna, Swati B. Wadavadagi PHI, New Delhi 2010.
4. Thermodynamics- An Engineering Approach YunusA.Cenegal and Michael A.Boles Tata McGraw Hill publications 2002

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=9GMBpZZtjXM&list=PLD8E646BAB3366BC8
- https://www.youtube.com/watch?v=jkdMtmXo664&list=PL3zvA_WajfGAwLuULH-L0AG9fKDgplYne
- https://www.youtube.com/watch?v=1lk7XLOxtzs&list=PLkn3QISf55zy2Nlqr5F09oO2qcIwNNfrZ&index=3
- https://www.youtube.com/watch?v=Dy2UeVCSRYs&list=PL2_EyjPqHc10CTN7cHiM5xB2qD7BHUry7

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Organise Industrial visits to Thermal power plants and submission of report
- Case study report and power point presentation on steam power plant
- .List of thermal energy devices at homes, hostels and college premises and applicable laws

TEMPLATE for AEC (if the course is a theory)

Introduction to Modelling and Design for Manufacturing		Semester	3
Course Code	**BMEL305**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	**0:0:2*:0**	SEE Marks	50
Total Hours of Pedagogy	**14 Sessions**	Total Marks	100
Credits	**01**	Exam Hours	3
Examination nature (SEE)	**Practical**		

***One hour per week can be taken additionally**

Course objectives:

1. To improve the visualisation skills and understand the conventions used in engineering drawing.
2. To inculcate understanding of the theory of projection and make drawings using orthographic projections and sectional views.
3. To impart fundamental knowledge of drawing of different machine parts.
4. To enable the students with concepts of dimensioning and standards related to drawings.
5. To enable the students to draw the assembly of various machine components.
6. To enable the students on limits, tolerance and fits and indicate them on machine drawings.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt online sharable playlist for students
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1

Introduction to Computer Aided Sketching Review of graphic interface of the software. Review of 2D Sketching, Parametric Solid Modeling, Assembly creation and product rendering.

Limits, Fits and Tolerances: Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, Types of fits with symbols and applications, Geometrical tolerances on drawings, Standards followed in industry. ***(Above topics to be studied as a review)***

01 Session

Geometrical Dimensioning and Tolerances (GD&T): Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, machining symbols, types of fits with symbols and applications, geometrical tolerances on drawings. Standards followed in industry. The basics of sketching and modelling:

Create a basic sketch - Profile Tools, Curve Tools, Editing Tools, Operation Tools, Constraints, construction geometries and adding dimensions. Part- Solid from sketches, Solid from surfaces, modify Tools, Operation Tools.

02 Sessions

Module-2 **02 Sessions**

Exploring design tools for production:

Create draft during a feature - Create draft as a feature - Add ribs and plastic supports - Analyze draft on a design - Create holes and threads - Use a coil feature - Mirrors and patterns - Surface creation for complex geometry - Use surfaces to replace faces - Use surfaces to split bodies and faces - Practice exercise.

Module-3 **03 Sessions**

The Basics of Assemblies

The different ways to create components - Use scripts to create gears - Component color swatch and color cycling - Use McMaster-Carr parts in a design - Copy, paste, and paste new. - Distributed designs - Create as-built joints - Create joints - Joint origins and midplane joints - Drive joints and motion studies - Interference detection and contact sets - Isolation and opacity control - Create groups and organize a timeline - Practice exercise.

Module-4 **06 Sessions**

Assembly Drawings: (Part drawings shall be given)

Drawing Basics-Detailing Drawings. Explode a 3D model for a drawing, Create a drawing sheet and views, Add geometry and dimensions to a drawing, Add GD & T text, BOM, tables and symbols, Place an exploded view, Edit a title block, Export to different file formats.

1. **Reciprocating saw mechanical assembly,**
2. **Innovated bottle design for sustainability**
3. **Engine Piston**
4. **Cylinder Flange**
5. **Engine Case**
6. **Design for Injection Molding**

1. Plummer block (Pedestal Bearing)
2. Rams Bottom Safety Valve
3. I.C. Engine connecting rod
4. Screw jack (Bottle type)
5. Tailstock of lathe
6. Machine vice
7. Lathe square tool post

Course outcome (Course Skill Set)

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

1. Demonstrate their visualization skills.
2. Apply limits and tolerances to assemblies and choose appropriate fits for given assemblies. Make component drawings.
3. Produce the assembly drawings using part drawings.
4. Engage in lifelong learning using sketching and drawing as communication tool.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation (CIE):

- CIE marks for the practical course is 50 Marks.
- CIE shall be evaluated for max marks 100. Marks obtained shall be accounted for CIE final marks, reducing it by 50%.
- CIE component should comprise of
  - Continuous evaluation of Drawing work of students as and when the Modules are covered.
  - At least one closed book Test covering all the modules on the basis of below detailed weightage.
  - *Weightage for Test and Continuous evaluation shall be suitably decided by respective course coordinators*.

Module	**Max. Marks weightage**	**Evaluation Weightage in marks**	
		Computer display & printout	**Preparatory sketching**
Module-1	15	10	05
Module-2	15	10	05
Module-3	20	15	05
Module-4	50	40	10
Total	**100**	**80**	**20**

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

- The duration of SEE is 03 hours. Questions shall be set worth of 3 hours
- SEE shall be conducted jointly by the two examiners (one internal and one external) appointed by the University.
- SEE shall be conducted and evaluated for maximum of 100 marks. Marks obtained shall be accounted for SEE final marks, reducing it to 50 marks.
- Question paper shall be set jointly by both examiners and made available for each batch as per schedule.
- Questions are to be set preferably from Text Books.
- Evaluation shall be carried jointly by both the examiners.
- Scheme of Evaluation: To be defined by the examiners jointly and the same shall be submitted to the university along with question paper.
- One full question shall be set from each Modules as per the below tabled weightage details. ***However, the student may be awarded full marks, if he/she completes solution on computer display without sketch***.

Module	Max. Marks Weightage	Evaluation Weightage in marks	
		Computer display & printout	Preparatory sketching
Module-1 OR Module-2	20	15	05
Module-3	20	15	05
Module-4	60	50	10
Total	**100**	**80**	**20**

Suggested Learning Resources:

Books

Text Books:

1. 'A Primer on Computer Aided Machine Drawing-2007', Published by VTU, Belgaum.
2. 'Machine Drawing', N.D.Bhat & V.M.Panchal, Published by Charotar Publishing House, 1999.
3. 'Machine Drawing', K.R. Gopala Krishna, Subhash publication.

Reference Book:

1. "A Text Book of Computer Aided Machine Drawing", S. Trymbakaa Murthy, CBS Publishers, New Delhi, 2007.
2. 'Machine Drawing', N.Siddeshwar, P.Kannaih, V.V.S. Sastri, published by Tata Mc.Grawhill, 2006.
3. K L Narayana, P Kannaiah, K Venkata Reddy, "Machine Drawing", New Age International, 3rd Edition. ISBN-13: 978-81-224-2518-5, 2006
4. Ajeet Singh, "MACHINE DRAWING", Tata McGraw-Hill Education,, ISBN: 9781259084607, 2012

Web links and Video Lectures (e-Resources):

- . https://www.autodesk.com/certification/learn/course/learn-fusion-360-in-90-minutes
- Introduction to Modelling and Design for Manufacturing
- https://www.autodesk.com/certification/learn/course/fusion360-intro-modeling-design-professional

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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Electric and Hybrid Vehicle Technology		Semester	3
Course Code	**BME306A**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	SEE Marks	50
Total Hours of Pedagogy	**40**	Total Marks	100
Credits	**03**	Exam Hours	3
Examination type (SEE)	**Theory**		

Course objectives:

- To understand the models, describe hybrid vehicles and their performance.
- To understand the different possible ways of energy storage.
- To understand the different strategies related to hybrid vehicle operation & energy management.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Videodemonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such asevaluating, generalizing, and analyzing information.

Module-1

Introduction to Electric Vehicle (EV) & Hybrid Vehicle(HV):

A brief history of Electric and Hybrid vehicles, basic architecture of hybrid drive train, vehicle motion and the dynamic equations for the vehicle, types of HV and EV, advantages over conventional vehicles, limitations of EV and HV, impact on environment of EV and HV technology, disposal of battery, cell and hazardous material and their impact on environment.

Module-2

Power Management and Energy Sources of EV and HV:

Power and Energy management strategies and its general architecture of EV and HV, various battery sources, energy storage, battery based energy storage, Battery Management Systems (BMS), fuel cells, their characteristics, Super capacitor based energy storage, flywheel, hybridization of various energy storage devices, Selection of the energy storage technology.

Module-3

DC and AC Machines & Drives in EV & HV:

Various types of motors, selection and size of motors, **Induction** motor drives and control characteristics, **Permanent** magnet motor drives and characteristics, **Brushed & Brushless** DC motor drive and characteristics, **switched reluctance motors** and characteristics, **IPM motor drives** and characteristics, mechanical and electrical connections of motors.

Module-4

Components & Design Considerations of EV & HV:

Design parameters of batteries, ultra-capacitors and fuel cells, aerodynamic considerations, calculation of the rolling resistance and the grade resistance, calculation of the acceleration force, total tractive effort, torque required on the drive wheel, transmission efficiency, consideration of vehicle mass.

Module-5

Electric and Hybrid Vehicles charging architecture:

Introduction to smart charging: Grid to vehicle and vehicle to grid, smart metering and ancillary services, preliminary discussion on vehicle to vehicle and vehicle to personal communication systems, introduction to battery charging stations and its installation and commissioning, preliminary discussion on estimation on station capacity and associated technical issues, different connectors.

Course outcome (Course Skill Set)

At the end of this course, students will demonstrate the ability to

1. Understand the architecture and vehicle dynamics of electric and hybrid vehicles
2. Analyze the power management systems for electric and hybrid vehicles
3. Understand different motor control strategies for electric and hybrid vehicles
4. Analyze various components of electric and hybrid vehicles with environment concern.
5. Understand the domain related grid interconnections of electric and hybrid vehicle.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours).

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), should have a mix of topics under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks.

Suggested Learning Resources:

Text Books

1. Iqbal Hussain, "Electric and Hybrid Vehicles Design Fundamentals", 1st Edition, CRC Press, 2003.
2. James Larminie, John Lowry "Electric Vehicle Technology Explained", 1st Edition, John Wiley and Sons, 2003.

3. Chris Mi, M. Abul Masrur, David Wenzhong Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", Wiley publication ,2011.
4. Allen Fuhs, "Hybrid Vehicles and the future of personal transportation", CRC Press, 2009.

Web links and Video Lectures (e-Resources):

1. Web course on "Introduction to Hybrid and Electric Vehicles" by Dr. Praveenkumar and Prof. S Majhi, IIT Guwahati available on NPTEL at https://nptel.ac.in/courses/108/103/108103009/
2. Video Course on "Electric Vehicles" by Prof. Amitkumar Jain, IIT Delhi available on NPTEL at https://nptel.ac.in/courses/108/102/108102121/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

	Smart Materials & Systems		Semester	III
	Course Code	**BME306B**	CIE Marks	50
	Teaching Hours/Week (L: T:P: S)	**3:0:0:0**	SEE Marks	50
	Total Hours of Pedagogy	**40**	Total Marks	100
	Credits	**03**	Exam Hours	03
	Examination type (SEE)	**Theory**		

Course objectives:

- To make the students understand about smart materials
- To make students to know about making of material smart
- To enable the students to appreciate the material properties

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Class room teaching through chalk & talk, PPT, Appropriate Videos, etc
2. Industry visit
3. Activity based learning
4. Display the sample materials in class room / laboratory

Module-1

Smart materials and structures: System intelligence- components and classification of smart structures, common smart materials and associated stimulus-response, Application areas of smart systems

Module-2

Electrically Activated Materials: Piezoelectricity, Piezoresistivity, Ferroelectricity, Piezoelectric materials- piezoelectric effect, Piezoceramics, Piezopolymers, Piezoelectric materials as sensors, Actuators and bimorphs, nanocarbon tubes

Module-3

Thermally activated materials: Shape memory materials; Shape memory alloys (SMAs), Classification - Transformation - Ni-Ti Alloys, Shape memory effect, Martensitic transformation, One way and two-way SME, binary and ternary alloy systems, Functional properties of SMAs, Shape memory ceramics - Shape memory polymers – Applications

Module-4

Smart polymers: Thermally responsive polymers, Electroactive polymers microgels, Synthesis, Properties and Applications, Protein-based smart polymers, pH-responsive and photo-responsive polymers, Self-assembly, Drug delivery using smart polymers

Module-5

Chemically Activated Materials - Chemical Gels - Self healing materials Optically Activated Materials - Optically activated polymers - Azobenzene - Liquid Crystal, Smart materials for space applications: Elastic memory composites, Smart corrosion protection coatings, Sensors, Actuators, Transducers,

Course outcome (Course Skill Set)

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

1. Apply the knowledge for materials characterisation
2. Evaluate the materials based on actuation
3. Select and justify appropriate materials for specific application

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. D.J. Leo, Engineering Analysis of Smart Material Systems, Wiley 2007.
2. M. Addington, D.L. Schodek, Smart Materials and New Technologies in Architecture, Elsevier 2005.
3. Donald R. Askeland and Pradeep P. Fulay, Essentials of Materials Science and Engineering, 2009, Cengage Laerning.

References

1. Gandi, M.V. and Thompson, B.S., "Smart Materials and Structures," Chapman & Hall, UK, 1992,
2. Culshaw, B., "Smart Structures and Materials," Artech House, Inc., Norwood, USA, 1996.
3. Dimitris C. Lagoudas, Shape Memory Alloys: Modelling and Engineering Applications, Springer, 2008.
4. T. Yoneyama & S. Mayazaki, Shape memory alloys for biomedical applications, CRCPress, 200

Web links and Video Lectures (e-Resources):

- Smart materials intelligent system design NPTEL course

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Prepare a smart material sample
- Visit to industry

INTERNET OF THINGS		Semester	3
Course Code	**BME306C**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	**3:0:0:0**	SEE Marks	50
Total Hours of Pedagogy	**40**	Total Marks	100
Credits	**03**	Exam Hours	
Examination type (SEE)	**Theory**		

Course objectives:

The Internet is evolving to connect people to physical things and also physical things to other physical things all in real time. It's becoming the Internet of Things (IoT). The course enables student to

- Understand the basics of Internet of things and protocols.
- Understand some of the application areas where Internet of Things can be applied.
- Learn about the middleware for Internet of Things.
- Understand the concepts of Web of Things

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes and make Teaching –Learning more effective

1. At the start of course, the course delivery pattern, prerequisite of the subject will be discussed
2. Lecture may be conducted with the aid of multi-media projector, chalk & Talk
3. Attendance is compulsory in lectures and laboratory, which may carries five marks in overall evaluation.
4. Promoting project based learning may be conducted having a share of 20 marks in the overall internal evaluation.
5. Assignment based on course content will be given to the student for each unit/topic and will be evaluated at regular interval. It may carry an importance of ten marks in the overall internal evaluation.
6. Surprise tests/Quizzes/Seminar/Tutorial may be conducted and having share of 10 marks in the overall internal evaluation.

Module-1

IOT - What is the IoT and why is it important? Elements of an IoT ecosystem, Technology drivers, Business drivers, Trends and implications, Overview of Governance, Privacy and Security Issues.

Module-2

IOT PROTOCOLS - Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Issues with IoT Standardization – Unified Data Standards – Protocols – IEEE802.15.4–BACNet Protocol– Modbus – KNX – Zigbee– Network layer – APS layer – Security

Module-3

IOT ARCHITECTURE - IoT Open source architecture (OIC)- OIC Architecture & Design principles- IoT Devices and deployment models- IoTivity: An Open source IoT stack - Overview- IoTivity stack architecture- Resource model and Abstraction.

Module-4

WEB OF THINGS - Web of Things versus Internet of Things – Two Pillars of the Web – Architecture Standardization for WoT– Platform Middleware for WoT – Unified Multitier WoT Architecture – WoT Portals and Business Intelligence.

Module-5

IOT APPLICATIONS - IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications. Study of existing IoT platforms /middleware, IoT- A, Hydra etc.

Course outcome (Course Skill Set)

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

1. Explain the definition and usage of the term "Internet of Things" in different contexts
2. Understand the key components that make up an IoT system
3. Differentiate between the levels of the IoT stack and be familiar with the key technologies and protocols employed at each layer of the stack
4. Apply the knowledge and skills acquired during the course to build and test a complete, working IoT system involving prototyping, programming and data analysis
5. Understand where the IoT concept fits within the broader ICT industry and possible future trends and Appreciate the role of big data, cloud computing and data analytics in a typical IoT system

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Text Books

1. Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", CRC Press,2012.
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011.
3. David Easley and Jon Kleinberg, "Networks, Crowds, and Markets: Reasoning About a Highly Connected World", Cambridge University Press, 2010.
4. Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things – Key applications and Protocols", Wiley, 2012.

References Books:

1. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)",1st Edition, VPT, 2014
2. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013
3. CunoPfister, Getting Started with the Internet of Things, O"Reilly Media, 2011, ISBN: 978-1-4493-9357-1

Web links and Video Lectures (e-Resources):

- Introduction to IoT - https://www.youtube.com/watch?v=WUYAjxnwjU4&list=PLE7VH8RC_N3bpVn-e8QzOAHziEgmjQ2qE
- https://www.coursera.org/learn/beginning-custom-projects-with-raspberry-pi
- https://www.edx.org/course/introduction-to-the-internet-of-things-3

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

1. Familiarization with Arduino/Raspberry Pi and perform necessary software installation.
2. To interface LED/Buzzer with Arduino/Raspberry Pi and write a program to turn ON LED for 1 sec after every 2 seconds.
3. To interface Push button/Digital sensor (IR/LDR) with Arduino/Raspberry Pi and write a program to turn ON LED when push button is pressed or at sensor detection.
4. To interface DHT11 sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings.
5. To interface motor using relay with Arduino/Raspberry Pi and write a program to turn ON motor when push button is pressed.
6. To interface OLED with Arduino/Raspberry Pi and write a program to print temperature and humidity readings on it.
7. To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to smartphone using Bluetooth.
8. To interface Bluetooth with Arduino/Raspberry Pi and write a program to turn LED ON/OFF when '1'/'0' is received from smartphone using Bluetooth.
9. Write a program on Arduino/Raspberry Pi to upload temperature and humidity data to thing speak cloud.
10. Write a program on Arduino/Raspberry Pi to retrieve temperature and humidity data from thing speak cloud.
11. To install MySQL database on Raspberry Pi and perform basic SQL queries.
12. Write a program on Arduino/Raspberry Pi to publish temperature data to MQTT broker.

	WASTE HANDLING & MANAGEMENT		Semester	**III**
	Course Code	**BME306D**	CIE Marks	50
	Teaching Hours/Week (L: T:P: S)	**3:0:0:0**	SEE Marks	50
	Total Hours of Pedagogy	**40**	Total Marks	100
	Credits	**03**	Exam Hours	03
	Examination type (SEE)	**Theory**		

Course objectives: To make students to understand about;

1. Waste generation & effects
2. Solid waste management & challenges
3. Hazordous waste management & challenges
4. Innovative methods in practice to handle waste & its effects
5. Laws governing the waste management

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Class room teaching through chalk & talk, PPT, Appropriate Videos, etc
2. Visit to nearby waste handling sites
3. Segregation of waste & Preparation of compost practical execution
4. Student speeches on their observations
5. Conduction / participation in Waste management idea formulation competition events
6. Case study discussions at least 4 in each topic mentioned

Module-1: Introduction to waste management

Importance, methods of logistics, human components, technological components- waste handling equipment and technology, steps in waste management logistics.
Waste collection system and organization: Environmental aspects of waste collection, role of public authority and private sector in waste collection, organizing collection of residential waste, fee schemes, public awareness programs.

Module-2 : Engineering Systems for Solid Waste Management

Characteristics of solid waste, types of solid waste, Processing and Treatment of Solid Waste; Mechanical Treatment Material Recovery Facility, Recycling and Recovery, Types of Material Recovery Facilities, Biological Treatment & Biological methods for waste processing; Composting & methods. Biomethanation, Biodeisel, Biohydrogen, Mechanical Biological Stabilization, Thermal Treatment Incineration, Residues and its utilisation, co-combustion, Pyrolysis, Gasification, Refuse Derived Fuel, solid recovered fuel.
Engineering Disposal of SW: Dumping of solid waste; sanitary land fills – site selection,.

Module-3 Hazardous Waste Management

Introduction, Hazardous waste definition, sources, identification and classification, Characteristics, Industrial waste & Plastic Waste; sources, environmental effects, challenges in handling Biomedical waste; Introduction to biomedical wastes, sources, classification, collection, segregation, treatment and disposal,
E- waste; characteristics, generation, collection, transport, recycling and disposal, Effects on the society and environment, Transportation and Disposal, recycling and reuse,
Nuclear waste; Characteristics, Types, Power reactors, Refinery and fuel fabrication wastes, Health and environmental effects, Decommissioning of Nuclear power reactors
Hazardous waste landfills, Site selections.

	Module-4 Innovations in waste management
	Global and Indian Context, recycling, reuse, energy production, land filling, remediation of hazardous waste contaminated sites. Revenue models, Developing Networks, Entrepreneurship activities, Best practices in India and Abroad- Case studies, Waste management and waste handling entrepreneurs in India and other countries, Case studies of different municipalities waste handling techniques, domestic composting, medium & large scale composting, Centralised composting
	Module-5 Waste Management Laws in India
	The Environmental Protection Act, The Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008, The Plastic Waste (Management and Handling) Rules, 2011, Bio-Medical Waste (Management and Handling) Rules, 1998, The E- Waste (Management and Handling) Rules, 2011, The Batteries (Management and Handling) Rules, 2001. Duties of constitutional bodies and Ministries

Course outcome (Course Skill Set)

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

1. Identify & segregate the waste
2. Formulate the appropriate waste segregation, collection & disposal system
3. Generate a report on waste management challenges
4. Select a remedial measure for environmental & living being protection
5. Exercise the constitution laws as a citizen

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Handbook of Solid Waste Management, Tchobanoglous G and Kreith F, McGraw-Hill Education, 2002, 2nd Edition
2. Hazardous Wastes - Sources, Pathways, Receptors, Richard J. Watts, John Wiley and Sons, 1998, 1st Edition.
3. Strategic Management,Hitt, M.A.,Hoskisson, R.E., Ireland, R.D., (2016)., Cengage Learning, India.
4. Waste Management Practices: Municipal, Hazardous and Industrial, John Pichtel, CRC Press, 2014, 2nd Edition
5. Handbook of Solid Waste Management, Tchobanoglous G and Kreith F, McGraw-Hill Education, 2002, 2nd Edition

Reference books:

1. Waste Management Practices: Municipal, Hazardous and Industrial, John Pichtel (2014)., 2nd Ed., CRC Press, USA.
2. Waste: A Handbook for Management, Letcher, T.M., Vallero, D.A. (2011)., 1st Ed, Academic Press, USA.
3. Waste Management Strategy and Action Plan,IGES, UNEP, CCET. (2018), Phnom Penh 2018-2035. Phnom Penh, Cambodia.
4. National Environment Policy, 2006, Ministry of Environment and Forests, Government of India, Approved by the Union Cabinet on 18 May, 2006 2
5. Innovation and Entrepreneurship, Peter Drucker, (2012)., Routledge Publishers, England UK

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/content/storage2/courses/105106056/Introduction.pdf
- https://nptel.ac.in/courses/105/103/105103205/
- http://cpheeo.gov.in/cms/manual-on-municipal-solid-waste-management-2016.php
- https://nptel.ac.in/courses/105/103/105103205/
- https://nptel.ac.in/courses/120/108/120108005/
- https://nptel.ac.in/courses/105/106/105106056/
- https://nptel.ac.in/courses/105/105/105105160/
- https://nptel.ac.in/courses/103/107/103107125/
- https://nptel.ac.in/courses/110/108/110108047/
- https://nptel.ac.in/courses/105/106/105106056/
- https://nptel.ac.in/courses/105/105/105105184/
- https://nptel.ac.in/content/storage2/courses/105106056/Introduction.pdf
- https://wedocs.unep.org/bitstream/handle/20.500.11822/31379/IWM_Guidelines.pdf?se quence=1&isAllowed=y

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Preparation of a model for waste management for a hostel, apartment, institution,
- Speeches by students about best practices followed for domestic waste handling
- Prepare compost using machines
- Visit nearby waste dump yard and prepare a report covering challenges & remedies
- Visit industries and observe large-scale industry waste disposal practices and challenges
- Visit near by hospitals and observe large-scale bio-medical waste disposal practices and challenges
- Display everyday one/ two constitution rules on class notice board
- Poster preparation by students

ADVANCED PYTHON PROGRAMMING		Semester	3
Course Code	**BME358A**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	**0:0:2:0**	SEE Marks	50
Total Hours of Pedagogy	**15**	Total Marks	100
Credits	**01**	Exam Hours	03
Examination type (SEE)	**Practical**		

Course objectives:

- To understand the problem solving approaches.
- To learn the basic programming constructs in Python.
- To practice various computing strategies for Python-based solutions to real world problems.
- To use Python data structures – lists, tuples, dictionaries.
- To do input/output with files in Python.

Sl.NO	Experiments
1	Demonstrate following functions/methods which operates on strings in Python with suitable examples: i) len( ) ii) strip( ) iii) rstrip( ) iv) lstrip( ) v) find( ) vi) rfind( ) vii) index( ) viii) rindex(),ix) count( ) x) replace( ) xi) split( ) xii) join( ) xiii) upper( ) xiv) lower( ) xv) swapcase( ) xvi) title( ) xvii) capitalize( ) xviii) startswith() xix) endswith()
2	Implementing programs using Functions. (Factorial, largest number in a list, area of shape).
3	NESTED LISTS: Write a program to read a 3 X 3 matrix and find the transpose, addition, subtraction, multiplication of two 3 X 3 matrices, check whether two given 3 X 3 matrices are identical or not.
4	Implementing programs using Strings. (Reverse, palindrome, character count, replacing characters). Real time applications using sets and Dictionaries
5	Scientific problems using Conditionals and Iterative loops. (Number series and different Patterns).
6	Numpy Library: Linear Algebra a) Write a python program to find rank, determinant, and trace of an array. b) Write a python program to find eigen values of matrices d) Write a python program to solve a linear matrix equation, or system of linear scalar equations.
7	Graphics: • Consider turtle object. Write functions to draw triangle, rectangle, polygon, circle and sphere. Use object oriented approach. • Design a Python program using the Turtle graphics library to construct a turtle bar chart representing the grades obtained by N students read from a file categorizing them into distinction, first class, second class, third class and failed.
8	Create a colour images using NumPy in Python.
	Demonstration Experiments (For CIE)
9	Write a python program to implement Pandas Series with labels.
10	Implementing real-time/technical applications using File handling. (copy from one file to another, word count, longest word).
11	Implementing real-time/technical applications using Exception handling. (divide by zero error, voter's age validity, student mark range validation).
12	Developing a game activity using Pygame like bouncing ball, car race etc.

Course outcomes (Course Skill Set):

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

- CO1: Develop algorithmic solutions to simple computational problems.
- CO2: Develop and execute simple Python programs.
- CO3: Use functions to decompose a Python program.
- CO4: Process compound data using Python data structures.
- CO5: Utilize Python packages in developing software applications.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation (CIE):

CIE marks for the practical course are **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before

the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.

- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
- General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)
- Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

- G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion Press, 2021.
- John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data", Third Edition, MIT Press, 2021
- Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.
- Eric Matthes, "Python Crash Course, A Hands – on Project Based Introduction to Programming", 2nd Edition, No Starch Press, 2019.
- Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc-Graw Hill, 2018.

TEMPLATE for AEC (if the course is a theory)

INTRODUCTION TO VIRTUAL REALITY		Semester	3rd
Course Code	**BME358B**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	**0-2-0-0**	SEE Marks	50
Total Hours of Pedagogy	**30**	Total Marks	100
Credits	**01**	Exam Hours	01
Examination nature (SEE)	**Theory**/practical/Viva-Voce /Term-work/Others		

Course objectives:

- Describe how VR systems work and list the applications of VR.
- Understand the design and implementation of the hardware that enables VR systems to be built.
- Understand the system of human vision and its implication on perception and rendering.
- Explain the concepts of motion and tracking in VR systems.
- Describe the importance of interaction and audio in VR systems.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Adopt flipped classroom teaching method.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analyzing information.

Module-1	
Introduction to Virtual Reality : Defining Virtual Reality, History of VR, Human Physiology and Perception, Key Elements of Virtual Reality Experience, Virtual Reality System, Interface to the Virtual World-Input & output- Visual, Aural & Haptic Displays, Applications of Virtual Reality.	
Teaching- Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Module-2	
Representing the Virtual World : Representation of the Virtual World, Visual Representation in VR, Aural Representation in VR and Haptic Representation in VR	
Teaching- Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Module-3	
The Geometry of Virtual Worlds &The Physiology of Human Vision: Geometric Models, Changing Position and Orientation, Axis-Angle Representations of Rotation, Viewing Transformations, Chaining the Transformations, Human Eye, eye movements & implications for VR.	
Teaching- Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Module-4	

Visual Perception & Rendering: Visual Perception - Perception of Depth, Perception of Motion, Perception of Color, Combining Sources of Information Visual Rendering -Ray Tracing and Shading Models, Rasterization, Correcting Optical Distortions, Improving Latency and Frame Rates	
Teaching- Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Module-5	
Motion & Tracking: Motion in Real and Virtual Worlds- Velocities and Accelerations, The Vestibular System, Physics in the Virtual World, Mismatched Motion and Vection Tracking- Tracking 2D & 3D Orientation, Tracking Position and Orientation, Tracking Attached Bodies	
Teaching- Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Course outcome (Course Skill Set) At the end of the course the student will be able to: CO1: Describe how VR systems work and list the applications of VR. CO2: Demonstrate the design and implementation of the hardware that enables VR systems to be built. CO3: Understand the system of human vision and its implication on perception and rendering. CO4: Explain the concepts of motion and tracking in VR systems. CO5: Describe the importance of interaction and audio in VR systems.	

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Text Books

1. Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016
2. Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig, (The Morgan Kaufmann Series in Computer Graphics)". Morgan Kaufmann Publishers, San Francisco, CA, 2002.
3. Developing Virtual Reality Applications: Foundations of Effective Design, Alan B Craig, William R Sherman and Jeffrey D Will, Morgan Kaufmann, 2009.

Reference Books:

1. Gerard Jounghyun Kim, "Designing Virtual Systems: The Structured Approach", 2005.
2. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, "3D User Interfaces, Theory and Practice", Addison Wesley, USA, 2005.
3. Oliver Bimber and Ramesh Raskar, "Spatial Augmented Reality: Meging Real and Virtual Worlds", 2005.
4. Burdea, Grigore C and Philippe Coiffet, "Virtual Reality Technology", Wiley Interscience, India, 2003.

Web links and Video Lectures (e-Resources):

- http://lavalle.pl/vr/book.html
- https://nptel.ac.in/courses/106/106/106106138/
- https://www.coursera.org/learn/introduction-virtual-reality.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Course seminars

SPREADSHEET FOR ENGINEERS		Semester	3
Course Code	**BME358C**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	**0:0:2:0**	SEE Marks	50
Total Hours of Pedagogy	**15 sessions**	Total Marks	100
Credits	**1**	Exam Hours	03
Examination type (SEE)	**Practical**		

Course objectives:

- To create different plots and charts
- To compute different functions, conditional functions and make regression analysis
- To carryout iterative solutions for roots, multiple roots, optimization and non-linear regression analysis
- To carryout matrix operations
- To Understand VBA and UDF
- To understand VBA subroutines and Macros
- To carryout numerical integration and solving differential equations using different methods

Sl.NO	Experiments
1	Charting: Create an XY scatter graph, XY chart with two Y-Axes, add error bars to your plot, create a combination chart
2	Functions: Computing Sum, Average, Count, Max and Min, Computing Weighted Average, Trigonometric Functions, Exponential Functions, Using The CONVERT Function to Convert Units
3	Conditional Functions: Logical Expressions, Boolean Functions, IF Function, Creating a Quadratic Equation Solver, Table VLOOKUP Function, AND, OR and XOR functions.
4	Regression Analysis: Trendline, Slope and Intercept, Interpolation and Forecast, The LINEST Function, Multilinear Regression, Polynomial Fit Functions, Residuals Plot, Slope and Tangent, Analysis ToolPack.
5	Iterative Solutions Using Excel: Using Goal Seek in Excel, Using The Solver To Find Roots, Finding Multiple Roots, Optimization Using The Solver, Minimization Analysis, NonLinear Regression Analysis.
6	Matrix Operations Using Excel: Adding Two Matrices, Multiplying a Matrix by a Scalar, Multiplying Two Matrices, Transposing a Matrix, Inverting a Matrix and Solving System of Linear Equations.
7	VBA User-Defined Functions (UDF): The Visual Basic Editor (VBE), The IF Structure, The Select Case Structure, The For Next Structure, The Do Loop Structure, Declaring Variables and Data Types, An Array Function The Excel Object Model, For Each Next Structure.
8	VBA Subroutines or Macros: Recording a Macro, Coding a Macro Finding Roots by Bisection, Using Arrays, Adding a Control and Creating User Forms.
	Demonstration Experiments (For CIE)
9	Numerical Integration Using Excel: The Rectangle Rule, The Trapezoid Rule, The Simpson's Rule, Creating a User-Defined Function Using the Simpson's Rule.
10	Differential Equations: Euler's Method, Modified Euler's Method, The Runge Kutta Method, Solving a Second Order Differential Equation

Course outcomes (Course Skill Set):

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

- Create different plots and charts
- Compute different functions, conditional functions and make regression analysis
- Carryout iterative solutions for roots, multiple roots, optimization and non-linear regression analysis
- Carryout matrix operations

- Understand VBA and UDF, VBA subroutines and Macros
- Carryout numerical integration and solving differential equations using different methods

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation (CIE):

CIE marks for the practical course are **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement

evaluation rubrics shall be decided jointly by examiners.

- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 03 hours

Suggested Learning Resources:

- Excel Resources - 600+ Self Study Guides, Articles & Tools (wallstreetmojo.com)
- https://www.ictlounge.com/html/year_7/esafety_part7.htm
- McFedries PaulMicrosoft Excel 2019 Formulas And Functions Microsoft Press, U.S, 2019 Edition

Tools in Scientific Computing		Semester	3
Course Code	**BME358D**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	**0:0:2:0**	SEE Marks	50
Total Hours of Pedagogy	**15 sessions**	Total Marks	100
Credits	**01**	Exam Hours	03
Examination type (SEE)	Theory/**Practical**/Viva-Voce /Term-work/Others		

Course objectives:

1. To learn the fundamentals of problem-solving using MATLAB/MATHCAD and go plot graphs using Origin software
2. To introduce programming for curve fitting and solving both linear and nonlinear equations.
3. To understand the concept of approximate methods and recognize their significance in computing.

Sl.NO	Experiments
1	Develop a program to find the eigenvalues and eigenvectors of a square matrix
2	Develop a user-friendly program for the Newton-Raphson method for solving simultaneous nonlinear equations
3	Develop a user-friendly program to find solution of simultaneous linear equations using matrix methods
4	Develop a program to find the equation that best fits for the given set of points using any of the curve fitting techniques
5	Develop a program to compute the area under the given curve described by the function using numerical techniques
6	Develop a user-friendly program for the thick or thin cylinders subjected to internal and external loads, determine the stresses developed within the cylinder and plot the variation of stresses
7	Develop a program to find the principal stresses and their associated directions for a given state of stress described by the components of stress in three dimensions (σxx, σyy, σzz, σxy, σxz, σyz),
8	Develop a user-friendly program for plotting the Mohr's circle for the given 2D stress state and determine the principal stresses and directions of principle stress
	Demonstration Experiments (For CIE)
9	Develop a program to find the multiplication and inverse of a square matrix
10	Develop a program to find and plot the response of spring-mass-dashpot system subjected to hormonic excitation.
11	Develop a program to find the roots of a quadratic equation using numerical methods
12	Develop a program to find the solution of differential equation using approximate methods

Course outcomes (Course Skill Set):

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

1. Understand the fundamentals of programming in scientific computations.
2. Develop programming for curve fitting and solving both linear and nonlinear equations.
3. Apply the concept of approximate methods and recognize their significance in computing.
4. Apply MATLAB/MATHCAD/FORTRAN/PYTHON tools, etc., for solving engineering problems

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation (CIE):

CIE marks for the practical course are **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.

- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 03 hours

Suggested Learning Resources:

1. Applied Numerical Methods with MATLAB for Engineers and Scientists, Steven C. Chapra, Edition 3, McGraw-Hill, 2012
2. Numerical methods for engineers, Steven C. Chapra, Raymond P. Canale, 5th fifth edition, 2006, McGraw-Hill Higher Education, Boston, 2006
3. MATLAB and Its Applications in Engineering, Raj Kumar Bansal, et.al 2009, Pearson Education,

APPLIED THERMODYNAMICS		Semester	4
Course Code	**BME401**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	**2:2:0:0**	SEE Marks	50
Total Hours of Pedagogy	**30**	Total Marks	100
Credits	**03**	Exam Hours	03
Examination type (SEE)	**Theory**		

Course objectives:

- Explain the air standard cycle and combustion in I. C. Engines.
- Describe the gas power cycle and vapour power cycles.
- Explain the performance of compressor.
- Explain the concepts of Refrigeration and Air conditioning.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Adopt flipped classroom teaching method.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1

Air standard cycles: Carnot cycle. Otto, Diesel, Dual and cycles, p-v and T -s diagrams, description, efficiencies and mean effective pressures. Comparison of Otto and Diesel cycles.

I.C.Engines: Classification of IC engines, Combustion of SI engine and CI engine, Detonation and factors affecting detonation, Performance analysis of I.C Engines, Heat balance, Morse test

Module-2

Gas power Cycles: Gas turbine (Brayton) cycle; description and analysis. Regenerative, Intercooling and reheating in gas turbine cycles.

Jet Propulsion cycles: Turbojet, Turboprop, Turbofan, Ram Jet, Rocket, Pulse Jet, Ram Rocket.

Module-3

Vapour Power Cycles: Carnot vapour power cycle, drawbacks as a reference cycle. Simple Rankine cycle; description, T-S diagram, analysis for performance. Comparison of Carnot and Rankine cycles. Effects of pressure and temperature on Rankine cycle performance.

Actual vapour power cycles: Actual vapour power cycles, regenerative vapour power cycle with open and closed feed water heaters. Reheat Rankine cycle.

Module-4

Refrigeration Cycles: Vapour compression refrigeration system; description, analysis, refrigerating effect. Capacity, power required, units of refrigeration, COP, Refrigerants and their desirable properties, alternate Refrigerants. Vapour absorption refrigeration system.

Pscychrometrics and Air-conditioning Systems: Psychometric properties of Air (***only for review***), Psychometric Chart, Analyzing Air-conditioning Processes; Heating, Cooling, Dehumidification and Humidification, Evaporative Cooling. Adiabatic mixing of two moist air streams.

Module-5

Reciprocating Compressors: Operation of a single stage reciprocating compressors. Work input through p-v diagram and steady state steady flow analysis. Effect of Clearance and Volumetric efficiency. Adiabatic, Isothermal and Mechanical efficiencies. Multi-stage compressor, saving in work, Optimum intermediate pressure, Inter-cooling, Minimum work for compression.

Steam nozzles: Flow of steam through nozzles, Shape of nozzles, effect of friction, Critical pressure ratio, Super saturated flow.

Course outcome (Course Skill Set)

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

1. Analyse air standard cycle to evaluate the performance of I C engines.
2. Analyze the gas power cycles to evaluate the overall efficiency of gas turbine plant.
3. Apply thermodynamic concepts to analyze the performance of vapour power cycles.
4. Analyze the vapour compression and vapour absorption systems to improve refrigeration.
5. Determination of various parameters of air compressors and steam nozzles.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books (Title of the Book/Name of the author/Name of the publisher/Edition and Year)

Text Books:

1. Engineering Thermodynamics, P.K. Nag, Tata McGraw Hill, 6th Edition 2018
2. Thermodynamics, Yunus A, Cengel, Michael A Boles, Tata McGraw Hill 7th Edition

Reference Books:

1. Thermodynamics for engineers Kenneth A. Kroosand Merle C. Potter, Cengage Learning 2016
2. Principles of Engineering Thermodynamics, Michael J, Moran,Howard N. Shapiro, Wiley 8th Edition
3. I.C.Engines, M.L.Mathur&Sharma. Dhanpat Rai& sons-India

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=AwbhbN20xl8&list=PLwdnzlV3ogoVJnW1S9GgOKYj5heOzl1dn
- https://ciechanow.ski/internal-combustion-engine/
- https://www.youtube.com/watch?v=1Vn1PDuPHsY&list=PL4K9r9dYCOoozyQU9kmQFJkTz

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Organise Industrial visits to Thermal power plants and submission of report.
- Visit to a building under construction to explore the design consideration of duct to understand the concept of centralized Air Conditioning.

MACHINING SCIENCE & METROLOGY		Semester	IV
Course Code	**BME402**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
Examination nature (SEE)	Theory /Viva-Voce /Term-work/Others		

Course objectives:

- To enrich the knowledge pertaining to relative motion and mechanics required for various machine tools.
- To introduce students to different machine tools to produce components having different shapes and sizes.
- To develop the knowledge on mechanics of machining process and effect of various parameters on machining.
- To understand the basic principles of measurements
- To enrich the knowledge pertaining to gauge , comparator and angular measurement.

Teaching-Learning Process (General Instructions)

These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different teaching methods to develop the outcomes through presentations/ video demonstrations/ simulations.
2. Chalk and talk method for problem-solving.
3. Arrange industrial visits to show the live working models other than laboratory topics.
4. Adopt collaborative learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analyzing information.
6. Conduct laboratory demonstrations and practical experiments to enhance experiential skills.

MODULE-1

Introduction to Metal cutting: Orthogonal and oblique cutting. Classification of cutting tools: single, and multipoint; tool signature for single point cutting tool. Mechanics of orthogonal cutting; chip formation, shear angle and its significance, Merchant circle diagram. Numerical problems. Cutting tool materials and applications.

Introduction to basic metal cutting machine tools: Lathe- Parts of lathe machine, accessories of lathe Machine and various operations carried out on lathe. Kinematics of lathe. Turret and Capstan lathe.

MODULE-2

Milling Machines: up milling & down milling, classification of milling machines, constructional features (Column and Knee and vertical milling machine), milling cutter nomenclature, various milling operations, calculation of machining time.

Indexing: Need of indexing Simple, compound and differential indexing calculations. Simple numerical on indexing.

Shaping, Slotting and Planning Machines Tools: Driving mechanisms of Shaper, Slotter and Planer. Operations done on Shaper, Planer & Slotter Difference between shaping and planning operations.

Drilling Machines: Constructional features (Radial & Bench drilling Machines), operations, types of drill & drill bit nomenclature. Calculation of machining time.

Grinding: Grinding operation, classification of grinding processes: cylindrical, surface &centerless grinding

MODULE-3
Thermal aspects, Tool wear, and Machinability **Temperature in Metal Cutting**: Heat generation in metal cutting; temperature distribution in metal cutting, effect of cutting speed on temperatures, measurement of cutting temperatures Tool life and tool Wear: progressive tool wear; **forms of wear in metal cutting:** crater wear, flank wear, tool-life criteria, cutting tool materials: basic requirements of tool materials, major classes of tool materials: high-speed steel, cemented carbide, ceramics, CBN and diamond, tool coatings; the work material and its machinability **Cutting fluids:** Action of coolants and application of cutting fluids.
MODULE-4
Introduction: Introduction to metrology & measurements, definition, objectives and classification of metrology, standards of length- wave length standard, sub division of standards, numerical problems on length calibration. **Line & End Standards:** Line and end standard, slip gauges, wringing phenomena, numerical problems on slip gauges. **Systems of Limits, Fits & Tolerance:** Definition of tolerance, tolerance specification in assembly, principle of interchangeability and selective assembly, limits of size, Indian standards, concepts of limits of size and tolerances, cost v/s tolerances, compound tolerances, accumulation of tolerances, definition of fits, types of fits and their designation.
MODULE-5
Gauges: Classification of gauges, Taylor's principle, design of GO, NO GO gauges, wear allowance on gauges, types of gauges- plain plug gauges, ring gauges, snap gauge, limit gauge, simple problems. **Comparators:** Introduction to comparators, classification, characteristics, systems of displacement amplification in mechanical comparators, Reed type, Sigma comparator, Zeiss ultra-optimeter, Solex air gauge, ultrasonic gauges, LVDT. **Angular Measurements:** Bevel protractor, sine bar, angular gauges, numerical on building of angles.

PRACTICAL COMPONENT OF IPCC *(May cover all / major modules)*

Sl.NO	Experiments
1	Preparation of one model on lathe involving - Plain turning, Facing, Knurling, Drilling, Boring, Internal Thread cuts and Eccentric turning.
2	Preparation of One model on lathe involving - Plain turning, Facing , Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning.
3	One Job, Cutting of V Groove/ dovetail / Rectangular groove using a shaper.
4	Cutting of Gear Teeth using Milling Machine.
5	Simple operations and One Job on the drilling and grinding machine.
6	Cutting force measurement with dynamometers (Demonstration) for turning, drilling, grinding operations.
7	Analysis of chip formation and chip reduction coefficient in turning of mild steel by HSS tool with different depth of cut, speed, and feed rate.
8	Experiment on anyone advanced machining process
9	Study & Demonstration of power tools like power drill, power hacksaw, portable hand grinding, cordless screw drivers, production air tools, wood cutter, etc., used in Mechanical Engineering.
10	Demonstration/Experimentation of simple programming of CNC machine operations.
11	Demonstration / Experiment on tool wears and tool life on anyone conventional machining process.
12	To study the tool geometry of a single point turning tool (SPTT) in the American Standards Association (ASA) system.

Course outcomes (Course Skill Set):

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

CO1: Analyze various cutting parameters in metal cutting.

CO2: Understand the construction of machines & machine tools and compute the machining time of various operations.

CO3: Understand the concept of Temperature in Metal Cutting, forms of wear in metal cutting and Cutting fluids

CO4: Understand the objectives of metrology, methods of measurement, standards of measurement & various measurement parameters. Explain tolerance, limits of size, fits, geometric and position tolerances, gauges and their design

CO5: Understand the working principle of different types of comparators, gauges, angular Measurements

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.

- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**)

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- Marks scored by the student shall be proportionally scaled down to 50 Marks

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper may include questions from the practical component.

Suggested Learning Resources:

Books

1. Shaw, M C, (2014), Metal Cutting Principles, Oxford University Press.
2. McGeough, J A, (1988), Advanced Methods of Machining, Springer.
3. Boothroyd, G., and Knight, W. A., Fundamentals of Machining and Machine Tools, CRC Press.
4. Chattopadhyay, A B, (2013), Machining and Machine Tools, Wiley India.
5. Mikell P. Groover, (2019), Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, Wiley Publications.
6. Rao P. N., Manufacturing Technology II, Tata McGraw Hill.
7. Mechanical Measurements Beckwith Marangoni and Lienhard Pearson Education 6th Ed.,
8. Instrumentation, Measurement and Analysis B C Nakra, K K Chaudhry McGraw–Hill 4th Edition
9. Engineering Metrology R.K. Jain Khanna Publishers 2009

Web links and Video Lectures (e-Resources):

1. V. K. Jain, Advanced Machining Processes, NPTEL Course Department of Mechanical Engineering, IIT Kanpur, Link: http://nptel.ac.in/courses/112104028/.
2. U. S. Dixit, Mechanics of Machining, NPTEL Course Department of Mechanical Engineering Guwahati, Link: http://nptel.ac.in/courses/112103248/.
3. A. B. Chattopadhyay, Manufacturing Processes II, NPTEL Course of Department of Mechanical Engineering, IIT Kharagpur, https://nptel.ac.in/courses/112/105/112105126/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

Visit any one machining center or machining industry and/or
Case study on process parameter influence on anyone advanced machining process and hybrid machining process.

FLUID MECHANICS		Semester	04
Course Code	**BME403**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
Examination nature (SEE)	**Theory**		

Course objectives:

- To have a working knowledge of the basic properties of fluids and understand the continuum approximation.
- To Calculate the forces exerted by a fluid at rest on submerged surfaces and understand the force of buoyancy.
- To understand the flow characteristic and dynamics of flow field for various Engineering applications.
- To know how velocity changes and energy transfers in fluid flows are related to forces and torques and to understand why designing for minimum loss of energy in fluid flows is so important.
- To discuss the main properties of laminar and turbulent pipe flow and appreciate their differences and the concept of boundary layer theory.
- Understand the concept of dynamic similarity and how to apply it to experimental modelling.
- To appreciate the consequences of compressibility in gas flow and understand the effects of friction and heat transfer on compressible flows.

Teaching-Learning Process (General Instructions)

These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.

1. Power-point Presentation,
2. Video demonstration or Simulations
3. Chalk and Talk are used for Problem Solving
4. Laboratory Demonstrations and Practical Experiments

MODULE-1

Basics: Introduction, Properties of fluids-mass density, weight density, specific volume, specific gravity, viscosity, surface tension, capillarity, vapour pressure, compressibility and bulk modulus. Concept of continuum, types of fluids etc,pressure at a point in the static mass of fluid, variation of pressure, Pascal's law,Absolute, gauge, atmospheric and vacuum pressures pressure measurement by simple, differential manometers and mechanical gauges.

Fluid Statics: Total pressure and center of pressure for horizontal plane, vertical plane surface and inclined plane surface submerged in static fluid.

MODULE-2

Fluid Kinematics: Types of Flow-steady, unsteady, uniform, non-uniform, laminar, turbulent, one, two and three dimensional, compressible, incompressible, rotational, irrotational, stream lines, path lines, streak lines, velocity components, convective and local acceleration, velocity potential, stream function, continuity equation in Cartesian co-ordinates. Rotation, vorticity and circulation, Laplace equation in velocity potential and Poisson equation in stream function, flow net, Problems.

Laminar and Turbulent flow: Flow through circular pipe, between parallel plates, Power absorbed in viscous flow in bearings, Poiseuille equation.

MODULE-3

Fluid Dynamics: Momentum equation, Impacts of jets- force on fixed and moving vanes, flat and curved. Numericals.Euler's equation, Integration of Euler's equation to obtain Bernoulli's equation,

Bernoulli's theorem, Application of Bernoulli's theorem such as venture meter, orifice meter, rectangular and triangular notch, pitot tube, orifices etc., related numericals. **Loss of head due to friction in pipes,** Major and minor losses, pipes in series and parallel.
MODULE-4
Flow over bodies: Development of boundary layer, Lift and Drag, Flow around circular cylinders, spheres, aerofoils and flat plates, Streamlined and bluff bodies, boundary layer separation and its control. **Dimensional Analysis:** Derived quantities, dimensions of physical quantities, dimensional homogeneity, Rayleigh method, Buckingham Pi-theorem, dimensionless numbers, similitude, types of similitude.
MODULE-5
Compressible flows: Speed of sound, adiabatic and isentropic steady flow, Isentropic flow with area change stagnation and sonic properties, normal and oblique shocks, flow through nozzles. **Introduction to CFD:** Necessity, limitations, philosophy behind CFD, applications

PRACTICAL COMPONENT OF IPCC*(May cover all / major modules)*

Sl.NO	Experiments
1	Determine the viscosity of oil using Red wood viscometer and Say-bolt viscometer. **Can be Demo experiments for CIE**
2	Measurement of pressure using different Manometers for high and low pressure measurements (manometers using different manometric fluids).
3	Working principle of different flow meters and their calibration (orifice plate, venture meter, turbine, Rota meter, electromagnetic flow meter) **Can be Demo experiments for CIE**
4	Determination of head loss in pipes and pipe fittings having different diameters, different materials and different roughness
5	Reynolds apparatus to measure critical Reynolds number for pipe flows
6	Effect of change in cross section and application of the Bernoulli equation
7	Impact of jet on flat and curved plates
8	Measurement of coefficient of pressure distribution on a cylinder at different Reynolds Numbers
9	Effect of change in cross section and application of the Bernoulli equation
10	Working principle of different flow meters for open channel and their calibration
11	Determination of drag and lift co-efficients of standard objects using wind tunnel. **Can be Demo experiments for CIE**
12	Use any CFD package to study the flow over aerofoil/cylinder **Can be Demo experiments for CIE**

Course outcomes (Course Skill Set):

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

CO1: Identify and calculate the key fluid properties used in the analysis of fluid behavior.

CO2: Understand and apply the principles of pressure, buoyancy and floatation

CO3: Apply the knowledge of fluid dynamics while addressing problems of mechanical and chemical engineering.

CO4: Understand the concept of boundary layer in fluid flow and apply dimensional analysis to form dimensionless numbers in terms of input output variables.

CO5: Understand the basic concept of compressible flow and CFD

CO 6: Conduct basic experiments of fluid mechanics and understand the experimental uncertainties.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**)

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- Marks scored by the student shall be proportionally scaled down to 50 Marks

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper may include questions from the practical component.

Suggested Learning Resources:

Books

- Fox, R. W., Pitchard,P.J.,and McDonald, A. T., (2010), Introduction to Fluid Mechanics, 7thEdition, John Wiley & Sons Inc.
- Cimbala, J.M., Cengel, Y. A. (2010),Fluid Mechanics: Fundamentals and Applications, McGraw-Hill
- Frank M White., (2016), Fluid Mechanics, 8thEdition , McGraw-Hill

Additional References:

- A text book of Fluid Mechanics and Hydraulic Machines, Dr. R K Bansal, Laxmi publishers
- Fundamentals of Fluid Mechanics, Munson, Young, Okiishi&Hebsch, John Wiley Publicationss, 7th Edition

Web links and Video Lectures (e-Resources):

- Nptel.ac.in
- VTU, E- learning
- MOOCS
- Open courseware

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Industrial visits
- Course seminar
- Term project

Template for Practical Course and if AEC is a practical Course

MECHANICAL MEASUREMENTS AND METROLOGY LAB		Semester	4
Course Code	**BME404**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	**0:0:2:0**	SEE Marks	50
Total Hours of Pedagogy	**15 sessions**	Total Marks	100
Credits	**01**	Exam Hours	03
Examination nature (SEE)	**Practical**		

Course objectives:

1. To illustrate the theoretical concepts taught in Mechanical Measurements & Metrology through experiments.
2. To illustrate the use of various measuring tools measuring techniques.
3. To understand calibration techniques of various measuring devices.

Sl.NO	Experiments
1	**MECHANICAL MEASUREMENTS:** Calibration of Pressure Gauge
2	Calibration of Thermocouple
3	Calibration of LVDT
4	Calibration of Load cell
5	Determination of modulus of elasticity of a mild steel specimen using strain gauges.
6	**METROLOGY:** Measurements using Optical Projector / Toolmaker Microscope.
7	Measurement of angle using Sine Center / Sine bar / bevel protractor
8	Measurement of alignment using Autocollimator / Roller set
	Demonstration Experiments (For CIE)
9	Measurement of cutting tool forces using a) Lathe tool Dynamometer OR b) Drill tool Dynamometer.
10	. Measurements of Screw thread Parameters using two wire or Three-wire methods.
11	Measurements of Surface roughness, Using Tally Surf/Mechanical Comparator
12	Measurement of gear tooth profile using gear tooth Vernier /Gear tooth micrometer

Course outcomes (Course Skill Set):

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

1. To calibrate pressure gauge, thermocouple, LVDT, load cell, micrometer.
2. To measure angle using Sine Center/ Sine Bar/ Bevel Protractor, alignment using Autocollimator/ Roller set.
3. To demonstrate measurements using Optical Projector/Tool maker microscope, Optical flats.
4. To measure cutting tool forces using Lathe/Drill tool dynamometer.
5. To measure Screw thread parameters using 2-Wire or 3-Wire method, gear tooth profile using gear tooth vernier/Gear tooth micrometer.
6. To measure surface roughness using Tally Surf/ Mechanical Comparator.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation (CIE):

CIE marks for the practical course are **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and

scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners) Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero. The minimum duration of SEE is 02 hours
Suggested Learning Resources: •

NON TRADITIONAL MACHINING		Semester	IV
Course Code	**BME405A**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	**Theory**/practical/Viva-Voce /Term-work/Others		

Course Objectives:

- To learn various concepts related to modern machining processes & their applications.
- To appreciate the differences between conventional and non-conventional machining processes.
- To acquire a functional understanding of non-traditional manufacturing equipment.
- To know about various process parameters and their influence on performance and their applications.
- To impart knowledge on various types of energy involved in non-traditional machining processes.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Videodemonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such asevaluating, generalizing, and analyzing information.

Module-1

Introduction to Non-traditional machining

Introduction to Non-traditional machining, Need for Non-traditional machining process, Comparison between traditional and non-traditional machining, general classification Non-traditional machining processes, classification based on nature of energy employed in machining, selection of non-traditional machining processes, Specific advantages, limitations and applications of non-traditional machining processes.

Module-2

Ultrasonic Machining (USM):

Introduction, Equipment and material process, Effect of process parameters: Effect of amplitude and frequency, Effect of abrasive grain diameter, effect of slurry, tool & work material. Process characteristics: Material removal rate, tool wear, accuracy, surface finish, applications, advantages & limitations of USM.

Abrasive Jet Machining (AJM):

Introduction, Equipment and process of material removal, process variables: carrier gas, type of abrasive, work material, stand-off distance (SOD). Process characteristics-Material removal rate, Nozzle wear, accuracy & surface finish. Applications, advantages & limitations of AJM.

Module-3

Electrochemical machining (ECM):

Introduction, Principle of electro chemical machining, ECM equipment, elements of ECM operation, Chemistry of ECM. ECM Process characteristics: Material removal rate, accuracy, surface finish. Process parameters: Current density, Tool feed rate, Gap between tool & work piece, velocity of electrolyte flow, type of electrolyte, its concentration temperature, and choice of electrolytes. ECM Tooling: ECM tooling technique & example, Tool & insulation materials. Applications ECM: Electrochemical grinding and electrochemical honing process. Advantages, disadvantages and application of ECG, ECH.

Chemical Machining (CHM):

Elements of the process, Resists (maskants), Etchants. Types of chemical machining process-chemical

blanking process, chemical milling process. Process characteristics of CHM: material removal rate, accuracy, surface finish, advantages, limitations and applications of chemical machining process.

Module-4

Electrical Discharge Machining (EDM):

Introduction, mechanism of metal removal, EDM equipment: spark erosion generator (relaxation type), dielectric medium-its functions & desirable properties, electrode feed control system. Flushing types; pressure flushing, suction flushing, side flushing, pulsed flushing. EDM process parameters: Spark frequency, current & spark gap, surface finish, Heat Affected Zone. Advantages, limitations & applications of EDM, Electrical discharge grinding, Traveling wire EDM.

Plasma Arc Machining (PAM):

Introduction, non-thermal generation of plasma, equipment mechanism of metal removal, Plasma torch, process parameters, process characteristics. Safety precautions. Safety precautions, applications, advantages and limitations.

Module-5

Laser Beam Machining (LBM):

Introduction, generation of LASER, Equipment and mechanism of metal removal, LBM parameters and characteristics, Applications, Advantages & limitations.

Electron Beam Machining (EBM):

Introduction, Principle, equipment and mechanism of metal removal, applications, advantages and limitations.

Course outcome (Course Skill Set)

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

- **CO1:** **Describe** non-traditional machining process and **compare** with Traditional machining process. R**ecognize** the need for Non-traditional machining process.
- **CO2:** **Describe** the constructional features, performance parameters, process characteristics, applications, advantages, and limitations of USM, AJM and WJM.
- **CO3:** **Characterize** the need of Chemical and electro-chemical machining process along with the constructional features, process parameters, process characteristics, applications, advantages, and limitations.
- **CO4:** **Illustrate** the constructional feature of the equipment, process parameters, process characteristics, applications, advantages and limitations EDM & PAM

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

TEXT BOOKS:

1. Modern Machining Process by P.C Pandey and H S Shah, McGraw Hill Education India Pvt. Ltd. 2000
2. Wellar, E.J. "Non-Traditional Machining Processes", Society of Manufacturing Engineers Publications, 2nd Edition, Michigan, 1984.
3. Non Traditional Manufacturing Processes, by Gary F Benedict, Taylor & Francis

REFERENCE BOOKS:

1. Production technology, HMT, McGraw Hill Education India Pvt. Ltd. 2001
2. New Technology, Dr. Amitabha Bhattacharyya, The Institute of Engineers (India), 2000
3. Modern Machining process, Aditya, 2002.
4. Non-Conventional Machining, P.K.Mishra, The Institution of Engineers (India) Test book series, Narosa Publishing House – 2005.
5. Metals Handbook: Machining Volume 16, Joseph R. Davis (Editor), American Society of Metals (ASM)
6. Gary F. Benedict, ―Nontraditional manufacturing processes‖, Marcel Dekker, Inc. 1987.

Web links and Video Lectures (e-Resources):
• https://nptel.ac.in/courses/112105127
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning •

ENVIRONMENTAL STUDIES		Semester	IV
Course Code	**BME405B**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	**3:0:0:0**	SEE Marks	50
Total Hours of Pedagogy	**40 hr**	Total Marks	100
Credits	**03**	Exam Hours	3
Examination type (SEE)	**Theory**		

Course objectives:

To impart the knowledge and awareness for the environmental protection for real-time contribution during an execution of engineering practices in the society.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Visit to a local area to document environmental assets/ecosystems- River/forest/grassland/mountain
- Construction of Food chain/food web of the visited area
- To identify the sources of air/water/soil/noise pollution of any area.

Module-1

Introduction to Environmental Studies:

Multidisciplinary nature of environmental studies.

Scope and importance; Concept of sustainability and sustainable development.

Ecosystems: Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Module-2

Natural Resources: Renewable and Non-Renewable Resources:

Land resources and land-use change; Land degradation, soil erosion and desertification.

Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.

Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (International & Inter-state).

Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

Module-3

Biodiversity and Conservation:

Levels of biological diversity: Genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hotspots.

India as a mega-biodiversity nation; Endangered and endemic species of India.

Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

Environmental Pollution

Environmental Pollution: Types, causes, effects and controls; Air, water, soil and noise pollution.

Nuclear hazards and human health risks.

Solid waste management, Control measures of urban and industrial waste.

Module-4

Environmental Policies and Practices

Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture.

Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and Control of Pollution) Act; Wildlife (Protection) Act; Forest Conservation Act.

International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).
Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

Module-5

Human Communities and the Environment

Human population growth: Impacts on environment, human health and welfare.
Resettlement and rehabilitation of project affected persons; case studies.
Disaster management: Floods, Earthquake, Cyclones and Landslides.
Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan.
Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.
Environmental communication and public awareness, case studies (e.g., CNG vehicles in cities).

Course outcome (Course Skill Set)

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

CO1: Understand the basic concepts of environmental studies and natural resources.
CO2: Explain about the various eco-systems of nature.
CO3: Discuss different types of environmental pollutions and their control measures.
CO4: Explain the acquired knowledge about the various social aspects related to the environment.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Text Books:

1. Benny Joseph (2005)., *Environmental Studies*, New Delhi, Tata McGraw Hill Publishing co.Ltd
2. Erach Bharucha (2005)., *Textbook of Environmental Studies for Undergraduate Courses*,Hyderabad, Universities Press.

Reference Books:

1. Anji Reddy .M (2007), *Textbook of Environmental Sciences and Technology*, Hyderabad, BS Publications.
2. Y Anjaneyulu.(2004), Introduction to *Environmental Sciences*, BS Publications.
3. Climate Change: Science and Politics. (2021). Centre Science and Environment, New Delhi.
4. Gadgil, M., & Guha, R. (1993). This Fissured Land: An Ecological History of India. Univ. of California Press.
5. Gleeson, B. and Low, N. (eds.) (1999). Global Ethics and Environment, London, Routledge.
6. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. (2006). Principles of Conservation Biology. Sunderland: Sinauer Associates.
7. Nandini, N., Sunitha N., & Sucharita Tandon. (2019). A text book on Environmental Studies (AECC). Sapna Book House, Bengaluru.
8. Rosencranz, A., Divan, S., & Noble, M. L. (2001). Environmental law and policy in India.

Web links and Video Lectures (e-Resources):

- .www.eco-prayer.org
- www.teriin.org
- www.cpcb.nic.in
- www.indiaenvironmentportal.org.in
- www.sustainabledevelopment.un.org
- www.conserve-energy-future.com

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Study of common plants, insects, birds, and basic principles of identification.
- Study of simple ecosystems – pond, river, etc.

MEMS-Micro Electro Mechanical Systems		Semester	IV
Course Code	**BME 405C**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	**3:0:0:0**	SEE Marks	50
Total Hours of Pedagogy	**40**	Total Marks	100
Credits	**03**	Exam Hours	03
Examination type (SEE)	**Theory**/practical/Viva-Voce /Term-work/Others		

Course objectives:

1. Students are exposed to the MEMS technology & Miniaturization.
2. Students will understand the Process of Micro fabrication Techniques.
3. Students are made to understand the principles of system modelling.
4. Students are made to understand the working principles of Mechanical sensors and actuators.
5. Students are made to understand the working principles of Micro-Opto-Electro Mechanical Systems.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Power Point Presentation,
2. Chalk and Talk are used for Derivations and Correlations (In-general).
3. Video demonstration or Simulations.

Module-1

MEMS: Introduction, Production Engineering, Precision Engineering and Ultra- Precision Engineering, Integrated circuits, Micro Electro Mechanical Systems.

Module-2

Micromachining: Introduction, Photo Lithography, Structural and Sacrificial Materials, Etching, Surface Micromachining, Bulk versus Surface Micromachining, Wafer Bonding, LIGA.

Module-3

System Modelling: Introduction, Need for Modelling, System types, Basic Modelling Elements In Mechanical System, Basic Modelling Elements In Electrical Systems, Basic Modelling Elements In Fluid Systems and Thermal Systems.

Module-4

Mechanical sensors and actuators: Introduction, Principles of Sensing and Actuation, Beam and Cantilever, Micro Plates, Capacitive Effects, Piezo Electric Material as Sensing and Actuating Elements.

Module-5

Micro-Opto-Electro Mechanical Systems: Introduction, Fundamental Principles of MOEMS Technology, Review on Properties of Light, Light Modulators, Micro mirrors, Digital Micro mirror Device.

Course outcome (Course Skill Set):

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

1. Understand the working of MEMS technology & Miniaturization.
2. Explain the Process of Micro fabrication Techniques.
3. Explain the principles of system modelling.
4. Understand the working principles of Mechanical sensors and actuators.
5. Describe the working principles of Micro-Opto-Electro Mechanical Systems

Assessment Details (both CIE and SEE) :

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. MEMS- Nitaigour Premchand Mahalik, TMH 2007.
2. Micro and Smart Systems: G.K.Ananthasuresh, K.J.Vinoy, S.Gopalakrishnan, K.N.Bhat,V.K.Aatre,Wiley India 2010.
3. Design and Development Methodologies, Smart Material Systems and MEMS: V. Varadan, K. J. Vinoy, S. Goplakrishnan, Wiley.
4. MEMS & Microsystems: Design and Manufacture, Tai-Ran Hsu, Tata Mc-Graw-Hill.

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Gaining hands on Knowledge to work on ANSYS Tool
- Simulation of Cantilever Beam For Different Loads On ANSYS Tool.

ROBOTICS AND AUTOMATION		Semester	IV
Course Code	**BME405D**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	**3:0:0**	SEE Marks	50
Total Hours of Pedagogy	**40**	Total Marks	100
Credits	**03**	Exam Hours	3
Examination type (SEE)	**Theory**		

Course objectives:

- Gain knowledge of Robotics and automation.
- Understand the working methodology of robotics and automation.
- Write the program for robot for various applications

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Through Power Point Presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Encourage collaborative (Group) Learning in the class.
4. Ask at least three higher order Thinking questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.

Module-1

Industrial Automation: Definition, Types of automation, List basic Devices in Automated Systems, Distinguish Different Controllers Employed In Automated Systems. Identify Safety in Industrial Automation

Basic Concepts: Definition and origin of robotics – different types of robotics – various generations of robots – degrees of freedom – Asimov's laws of robotics

Module-2

Fundamentals of Robotics: robot anatomy, work volume, robot drive systems, control systems, precision of movement, end effectors, Introduction to Manipulator kinematics, Robot Dynamics**.**

Basic control systems and components: Basic control systems concepts and models, Controllers, control system analysis,

Module-3

Robot End Effector: Types of End effectors, Mechanical Grippers, Other types of Grippers, Tools and End effector, The Robot/End effector interface Consideration in Gripper selecting and Design.

Sensors in Robotics: Transducers and sensors, sensors in robotics, tactile sensors, proximity and range sensors, uses of sensors in robotics.

Module-4

Robot Programming: Methods of robot programming, lead -through programming methods, a robot program as a path in space, motion interpolation, wait, signal and delay commands, branching, capabilities and limitations of lead-through methods.

Module-5

Material handling and Identification Technologies: Overview of Material Handling Systems, Principles and Design Consideration, Material Transport Systems, Storage Systems, Overview of Automatic Identification Methods.

Course outcome (Course Skill Set)

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

CO 1: Explain various types of Robotics, automation, robotics motion, sensors and control, machine vision, robotic programming and roles of robots in industry.

CO 2: Understand the working methodology of robotics and automation, motion and control, machine vision and programming, application of robots in industry.

CO 3: Write the program for robot for various applications.

CO 4: Describe the different material handling and Identification technologies used in automation

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Mikell P. Groover, Mitchel Weiss, Roger N. Nagel, Nicholas G. Odrey and Ashish Dutta, "Industrial Robotics: Technology, Programming and Applications", 2 nd Edition, Tata McGraw Hill, 2012.
2. Roland Siegwart, Illah R. Nourbakhsh, an d Davide Scaramuzza, "Introduction to Autonomous Mobile Robots", 2 nd Edition, PHI, 2011

Web links and Video Lectures (e-Resources):

- NPTEL course on Industrial Robotics
- Videos on Industrial Automation

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Visit any automated production Industry understand the importance and applications of Robots in Automated Industry

INTRODUCTION TO AI & ML		Semester	IV
Course Code	**BME456A**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	**15 sessions**	Total Marks	100
Credits	01	Exam Hours	03
Examination type (SEE)	**PRACTICAL**		

Course objectives:

- Make use of Data sets in implementing the machine learning algorithms
- Implement the machine learning concepts and algorithms in any suitable language of choice.
- Analyse the working of various documents like PDF, Word file

Sl.NO	Experiments
1	Implement A* Search algorithm.
2	Implement AO* Search algorithm.
3	Write a program to implement Water jug program using AI.
4	The probability that it is Friday and that a student is absent is 3 %. Since there are 5 school days in a week, the probability that it is Friday is 20 %. What is the probability that a student is absent given that today is Friday? Apply Baye's rule in python to get the result.
5	Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.
6	For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.
7	Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets.
8	Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set. You can use Java/Python ML library classes/API
	Demonstration Experiments (For CIE)
9	Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.

Course outcomes (Course Skill Set):

- Understand the implementation procedures for the machine learning algorithms
- Design Java/Python programs for various Learning algorithms.
- Apply appropriate data sets to the Machine Learning algorithms
- Identify and apply Machine Learning algorithms to solve real world problems
- Examine working of PDF and word file formats

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation (CIE):

CIE marks for the practical course are**50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 03 hours

Suggested Learning Resources:

1. Tom M Mitchell,"Machine Lerning",1 st Edition, McGraw Hill Education, 2017.
2. 2. Elaine Rich, Kevin K and S B Nair, "Artificial Inteligence", 3rd Edition, McGraw Hill Education, 2017.

TEMPLATE for AEC (if the course is a theory) Annexure-IV

Digital Marketing		Semester	IV
Course Code	**BME456B**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	**1:0:0:0**	SEE Marks	50
Total Hours of Pedagogy	**15**	Total Marks	100
Credits	**01**	Exam Hours	01
Examination type (SEE)	**Theory**		

Course objectives:

- To focuses on the importance of digital marketing and its applications and to introduce current and core practices of Digital and Social Media Marketing that will allow learners to analyse, plan, execute and evaluate a digital marketing strategy.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.

Module-1

Introduction to Digital Marketing (DM)-Meaning, Definition, Need of DM, Scope of DM, History of DM, Concept and approaches to DM, Examples of good practices in DM. Email Marketing-Need for Emails, Types of Emails, options in Email advertising, Mobile Marketing.

Module-2

Social Media Marketing -Introduction to Blogging. Introduction to Face book, Twitter, Google +, LinkedIn, YouTube, Instagram and Pinterest; their channel advertising and campaigns.

Module-3

Acquiring & Engaging Users through Digital Channels: Understanding the relationship between content and branding and its impact on sales, search engine marketing, mobile marketing, video marketing, and social-media marketing.

Module-4

Designing Organization for Digital Success: Digital transformation, digital leadership principles, online P.R. and reputation management. ROI of digital strategies, how digital marketing is adding value to business, and evaluating cost effectiveness of digital strategies

Module-5

Digital Innovation and Trends: The contemporary digital revolution, digital transformation framework; security and privatization issues with digital marketing, Understanding trends in digital marketing – Indian and global context, online communities and co-creation.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 03 credit course, then

- The question paper will have ten questions. Each question is set for 10 marks.
- There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
- The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Books

1. Fundamentals of Digital Marketing by Puneet Singh Bhatia, Pearson
2. Moutsy Maiti: Internet Marketing, Oxford University Press India
3. Vandana, Ahuja; Digital Marketing, Oxford University Press India (November, 2015).
4. Eric Greenberg, and Kates, Alexander; Strategic Digital Marketing: Top Digital Experts
5. Share the Formula for Tangible Returns on Your Marketing Investment; McGraw-Hill
6. Professional (October, 2013).
7. Ryan, Damian; Understanding Digital Marketing: marketing strategies for engaging the
8. digital generation; Kogan Page (3rd Edition, 2014).
9. Tracy L. Tuten & Michael R. Solomon: Social Media Marketing (Sage Publication)

Web links and Video Lectures (e-Resources):

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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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INTRODUCTION TO DATA ANALYTICS		Semester	IV
Course Code	**BME456C**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	**15 sessions**	Total Marks	100
Credits	01	Exam Hours	03
Examination type (SEE)	**Practical**		

Course objectives:

- To understand Numpy, Pandas and Matplot library
- To understand basics of statistics
- To learn the basic of decision tree algorithm.
- To understand random forest algorithm and Anova
- To use Python data structures.
- To use excel in data analytics

Sl.NO	Experiments
1	Use Numpy to create single and multi-dimensional array and perform various operations using Python.
2	Use Pandas to access dataset, cleaning, manipulate data and analyze using Python
3	Use matplot library to plot graph for data visualization using Python
4	Determine probability, sampling and sampling distribution using Python
5	Determine frequency distributions, variability, average, and standard deviation using Python
6	Draw normal curves, correlation, correlation coefficient and scatter plots using Python
7	Implement and analyze Linear regression in Python (Single variable & Multivariable)
8	Implement and analyze Logistic regression in Python
9	Implement and analyze Decision tree algorithm in Python
10	Implement and analyze Random Forest algorithm in Python
	Only for CIE
11	Implementation of two samples T-test and paired two-sample T-test in excel.
12	Implementation of one-way and two-way ANOVA in excel.

Course outcomes (Course Skill Set):

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

- CO1: Analyze data using tools and represent for visualization
- CO2: Implement various statistical methods.
- CO3: Understand and use decision tree and random forest algorithm
- CO4: Understand and Implement T test and Anova

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation (CIE):

CIE marks for the practical course are **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

- General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)
- Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

- McKinney, W. (2012). Python for data analysis: Data wrangling with Pandas, NumPy, and IPython. " O'Reilly Media, Inc.".
- Swaroop, C. H. (2003). A Byte of Python. Python Tutorial.
- Ken Black, sixth Editing. Business Statistics for Contemporary Decision Making. “John Wiley & Sons, Inc”
- https://www.simplilearn.com/tutorials/data-analytics-tutorial/data-analytics-with-python
- https://www.youtube.com/watch?v=GPVsHOlRBBI&ab_channel=freeCodeCamp.org

Introduction to programming in C++		Semester	IV
Course Code	BME456D	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	15 sessions	Total Marks	100
Credits	01	Exam Hours	03
Examination type (SEE)	Practical		

Course objectives:

- To learn object-oriented programming concepts using the C++ language.
- To apply the principles of data abstraction, inheritance and polymorphism;
- To use the principles of virtual functions and polymorphism
- To learn how to handle formatted I/O and unformatted I/O

Sl.NO	Experiments
1	Write a C++ Program to display Names, Roll No., and grades of 3 students who have appeared in the examination. Declare the class of name, Roll No. and grade. Create an array of class objects. Read and display the contents of the array.
2	Write a C++ program to declare Struct. Initialize and display contents of member variables.
3	Write a C++ program to declare a class. Declare pointer to class. Initialize and display the contents of the class member.
4	Given that an EMPLOYEE class contains following members: data members: Employee number, Employee name, Basic, DA, IT, Net Salary and print data members.
5	Write a C++ program to read the data of N employee and compute Net salary of each employee (DA=52% of Basic and Income Tax (IT) =30% of the gross salary).
6	Write a C++ to illustrate the concepts of console I/O operations.
7	Write a C++ program to use scope resolution operator. Display the various values of the same
8	Write a C++ program to create an array of pointers. Invoke functions using array objects.
	Demonstration Experiments (For CIE)
9	Write a C++ program for Vehicle reservation system
10	Write a C++ program to Create a Modern Periodic Table
11	Write a C++ program to Develop a Bookshop inventory
12	Write a C++ program for Credit Card Validation System

Course outcomes (Course Skill Set):

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

CO1: Apply Object Oriented Programming concepts in C++

CO2: Write a C++ program by applying knowledge of mathematics, science, and engineering.

CO4: Function on multi-disciplinary teams.

CO5: Identify, formulate, and solve engineering problems.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation (CIE):

CIE marks for the practical course are **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
- General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100

marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

- Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.
- The minimum duration of SEE is 02 hours

Suggested Learning Resources:

1. The C++ Programming Language, 3rd Edition, B. Stroutstrup, Pearson Education.
2. OOP in C++, 3rd Edition, T. Gaddis, J. Walters and G. Muganda, Wiley Dream Tech Press.
3. Object Oriented Programming in C++, 3rd Edition, R. Lafore, Galigotia Publications Pvt Ltd.

Industrial Management & Entrepreneurship		Semester	6
Course Code	**BME501**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3-0-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	**Theory**		

Course objectives:

- Understand the basic concepts of management, planning, organizing, staffing, directing and controlling.
- Identify various types of supporting agencies and financing available for an entrepreneur
- Prepare project report and decide selection of industrial ownership.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby plants, start -up ecosystem, incubation centers or MSME industries to give information about the industry culture and demand.
3. Show Video/animation films to explain functioning of various machines
4. Encourage collaborative (Group Learning) Learning in the class
5. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
6. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

Module-1

Management: Introduction - Meaning - nature and characteristics of Management, Scope and Functional areas of management - Management as a science, art of profession - Management & Administration - Roles of Management, Levels of Management, Development of Management Thought- early management approaches –Modern management approaches.

Planning: Nature, importance and purpose of planning process Objectives - Types of plans (Meaning Only) - Decision making Importance of planning - steps in planning & planning premises - Hierarchy of plans.

Module-2

Organizing and Staffing: Nature and purpose of organization Principles of organization - Types of organization - Departmentation Committees Centralization Vs Decentralization of authority and responsibility - Span of control - MBO and MBE (Meaning Only) Nature and importance of staffing--Process of Selection & Recruitment(in brief).

Directing & Controlling: Meaning and nature of directing Leadership styles, Motivation Theories, Communication - Meaning and importance - coordination, meaning and importance and Techniques of Co Ordination. Meaning and steps in controlling - Essentials of a sound control system - Methods of establishing control (in brief).

Module-3

Entrepreneur: Meaning of Entrepreneur; Evolution of the Concept; Functions of an Entrepreneur, Types of Entrepreneurs, Entrepreneur - an emerging. Class. Concept of Entrepreneurship - Evolution of Entrepreneurship, Development of Entrepreneurship; Stages in entrepreneurial process; Role of entrepreneurs in Economic Development; Entrepreneurship in India; Entrepreneurship – its Barriers.

Module-4

Small Scale Industries: Definition; Characteristics; Need and rationale; Objectives; Scope; role of SSI in Economic Development. Advantages of SSI Steps to start and SSI - Government policy towards SSI; Different Policies of SSI; Government Support for SSI during 5 year plans. Impact of Liberalization, Privatization, Globalization on SSI Effect of WTO/GA TT Supporting Agencies of Government for SSI, Meaning, Nature of support; Objectives; Functions; Types of Help; Ancillary Industry and Tiny Industry

Module-5

Institutional Support: Different Schemes; TECKSOK; KIADB; KSSIDC; KSIMC; DIC Single Window Agency; SISI; NSIC; SIDBI; KSFC.

Preparation of Project: Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; Formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal. Identification of business opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study

Course outcome (Course Skill Set)

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

1. Explain about the management and planning.
2. Apply the knowledge on planning, organizing, staffing, directing and controlling.
3. Describe the requirements towards the small-scale industries and project preparation.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assessment methods mentioned in the 22OB4.2, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.

For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment for a total of 50 marks. **Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Principles of Management, P. C.Tripathi,P.N. Reddy, Tata McGraw Hill,
2. Dynamics of Entrepreneurial Development & Management, Vasant Desai, Publishing House.
3. Entrepreneurship Development, Poornima. M.Charantimath, Small Business Enterprises – Pearson, 2006 (2 & 4).
4. Management Fundamentals-Concepts, Application , Skill , RobersLusier –Thomson
5. Entrepreneurship Development, S.S.Khanka, S.Chand& Co
6. Management, Stephen Robbins, Pearson Education/PHI, 17th Edition, 2003

Web links and Video Lectures (e-Resources):

- www.nptel.ac.in
- https://onlinecourses.nptel.ac.in/noc23_mg74/preview
- https://onlinecourses.nptel.ac.in/noc23_mg70/preview
- https://cleartax.in/s/small-scaleindustriesssi#:~:text=Small%20Scale%20Industries%20(SSI)%20are,50%20crore
- https://www.startupindia.gov.in/content/sih/en/startup-scheme.html

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- At the end of the lecture/presentation, numerical exercises are to be taken up to solve problems related to the topics covered. Additional problems are to be given for practice and also as assignments under each of the topics covered.

TURBOMACHINES		Semester	V
Course Code	**BME502**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	3
Examination nature (SEE)	Theory		

Course objectives:

- Understand typical design of Turbo machine, their working principle, application and thermodynamics process involved.
- Study the conversion of fluid energy to mechanical energy in Turbo machine with utilization factor and degree of reaction.
- Analyse various designs of steam turbine and their working principle.
- Study the various designs of hydraulic turbine based on the working principle.
- Understand the various aspects in design of power absorbing machine.

Teaching-Learning Process (General Instructions)

These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Arrange visits to show the live working models other than laboratory topics.
- Adopt collaborative (Group Learning) Learning in the class.
- Adopt Problem Based Learning (PBL), which foster students' Analytical skills and develops
- Thinking skills such as evaluating, generalizing, and analyzing information.

MODULE-1

Introduction: Definition of turbo machine, parts of turbo machines, Comparison with positive displacement machines, Classification, Dimensionless parameters and their significance, Unit and specific quantities, model studies and its numerical. (Note: Since dimensional analysis is covered in Fluid Mechanics subject, the questions on dimensional analysis should not be given. However, dimensionless parameters and model studies may be given more weightage.)

Thermodynamics of fluid flow: Application of first and second law of thermodynamics to turbo machines, Efficiencies of turbo machines, Static and Stagnation states, overall isentropic efficiency, stage efficiency (their comparison) and polytropic efficiency for both compression and expansion processes. Reheat factor for expansion process. Simple Numerical on stage efficiency and polytropic efficiency.

MODULE-2

Energy exchange in Turbo machines: Euler's turbine equation, Alternate form of Euler's turbine equation, Velocity triangles for different values of degree of reaction, Components of energy transfer, Degree of Reaction, utilization factor, Relation between degree of reaction and Utilization factor, Problems.

General Analysis of Turbo machines: Radial flow compressors and pumps – general analysis, Expression for degree of reaction, velocity triangles, Effect of blade discharge angle on energy transfer and degree of reaction, Effect of blade discharge angle on performance, , General analysis of axial flow pumps and compressors, degree of reaction, velocity triangles, Numerical Problems.

MODULE-3

Steam Turbines: Classification, Single stage impulse turbine, condition for maximum blade efficiency, stage efficiency, Need and methods of compounding, Multi-stage impulse turbine, expression for maximum utilization factor, Numerical.

Reaction turbine: Parsons's turbine, condition for maximum utilization factor, reaction staging. Numerical.

MODULE-4

Hydraulic Turbines: Classification, various efficiencies. **Pelton Wheel** – Principle of working, velocity triangles, design parameters, maximum efficiency, and numerical.

Francis turbine – Principle of working, velocity triangles, design parameters, and numerical problems

Kaplan and Propeller turbines: Principle of working, velocity triangles, design parameters and Numerical. Theory and types of Draft tubes.

MODULE-5

Centrifugal Pumps: Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, Theoretical head – capacity relationship, Minimum speed for starting the flow, Maximum suction lift, Net positive suction head, Cavitation, Need for priming, Pumps in series and parallel. Problems.

Centrifugal Compressors: Stage velocity triangles, slip factor, power input factor, Stage work, Pressure developed, stage efficiency and surging and problems.

PRACTICAL COMPONENT OF IPCC *(May cover all / major modules)*

Sl.NO	Experiments
1	Performance analysis of Pelton Wheel
2	Performance analysis of Francis turbine
3	Performance analysis of Kaplan turbine
4	Performance analysis of centrifugal blowers
5	Performance analysis of centrifugal pump
6	Performance analysis of Axial Fan and Radial Fan

Course outcomes (Course Skill Set):

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

- Apply the Model studies and thermodynamics analysis of turbo machines.
- Analyse the energy transfers in Turbo machine with degree of reaction and utilisation factor.
- Classify, analyse and understand various type of steam turbine.
- Classify, analyse and understand various type of hydraulic turbine.
- Understand the concept of radial power absorbing machine and the problems involved during its operation.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25**

marks.

- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC

1. Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**)
2. The question paper will have ten questions. Each question is set for 20 marks.
3. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.
5. Marks scored by the student shall be proportionally scaled down to 50 Marks

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper may include questions from the practical component.

Suggested Learning Resources:

TEST BOOKS

1. V. Kadambi and Manohar Prasad, An Introduction to Energy Conversion, Volume III, Turbo machinery, New Age International Publishers, reprint 2008
2. M. S. Govinde Gowda, A Text of Turbo machines, 1st Edn, 2024, Iterative International Publishers (IIP), ISBN: 978-93-6252-884-1.

REFERENCE BOOKS

1. Principals of Turbo machines, D. G. Shepherd, The Macmillan Company (1964).
2. Fluid Mechanics & Thermodynamics of Turbo machines, S. L. Dixon, Elsevier (2005).
3. Turbines, Compressors & Fans, S. M. Yahya, Tata McGraw Hill Co. Ltd., 2nd edition, 2002.
4. B.K Venkanna, Fundamentals of Turbo Machinery, PHI Publishers

Web links and Video Lectures (e-Resources):

- https://www.tlv.com/global/TI/steam-theory/principal-applications-for-steam.html
- https://www.turboindustries.com/
- https://www.aeroprobe.com/turbomachinery-industry/
- https://www.mr-cfd.com/industries/turbomachinery/
- https://youtu.be/GIvV6XWaG-A
- https://youtu.be/_6FLj3Zpumo

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

1. Visit to Thermal power plant/Hydroelectric power plant
2. Visit to nearest pump station.
3. Video demonstration of latest trends in turbine manufacturing and pumps manufacturing units.

Theory of Machines		Semester	5
Course Code	**BME503**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	4:0:0:0	SEE Marks	50
Total Hours of Pedagogy	52	Total Marks	100
Credits	04	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

1. To understand the concept of machines, mechanisms and to Analyze a mechanism for displacement, velocity and acceleration at any point in a moving link.
2. To understand the force-motion relationship in components subjected to external forces and analysis of standard mechanisms
3. To understand the theory of gears and gear trains.
4. To understand the undesirable effects of unbalances resulting from prescribed motions in mechanism.
5. To understand the principles in mechanisms used for speed control and stability control.
6. To compute the natural and damped frequencies of free 1-DOF mechanical systems and to analyse the
   vibrational motion of 1-DOF mechanical systems under harmonic excitation conditions.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

Course objectives:

1. These are sample strategies, which teachers can use to accelerate the attainment of the various course outcomes.
2. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
3. Chalk and Talk method for Problem Solving.
4. Adopt flipped classroom teaching method.
5. Adopt collaborative (Group Learning) learning in the class.
6. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1

Introduction: Mechanisms and machines, Kinematic pairs-types, degree of freedom, Kinematic chains and their classification, Kinematic inversions,

Velocity and Acceleration analysis of planar mechanisms Graphical method: Velocity and Acceleration Analysis of Mechanisms Velocity and acceleration analysis of four bar mechanism, slider crank mechanism. Mechanism illustrating Coriolis component of acceleration. Angular velocity and angular acceleration of links, velocity of rubbing.

Velocity and Acceleration Analysis of Mechanisms (Analytical Method): Velocity and acceleration analysis of four bar mechanism, slider crank mechanism using complex algebra method.

Module-2

Static force analysis: Static equilibrium, analysis of four bar mechanism, slider crank mechanism.

Dynamic force analysis: D'Alembert's principle, analysis of four bar and slider crank mechanism.

Flywheel: Introduction to Flywheel and calculation of its size for simple machines like punching machine, shearing machine.

Module-3

Spur Gears: Gear terminology, law of gearing, path of contact, arc of contact, contact ratio of spur gear. Interference in involute gears, methods of avoiding interference, condition and expressions for minimum number of teeth to avoid interference.

Gear Trains: Simple gear trains, compound gear trains. Epicyclic gear trains: Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains, torque calculation in epicyclic gear trains. Discussions on applications of gear trains.

Module-4

Balancing of Rotating Masses: Static and Dynamic Balancing, balancing of single rotating mass by balancing masses in same plane and in different planes. Balancing of several rotating masses by balancing masses in same plane and in different planes. Discussions on applications.

Balancing of Reciprocating Masses: Inertia Effect of crank and connecting rod, Single cylinder Engine, Balancing in multi cylinder-inline engine (primary and secondary forces). Discussions on applications

Governors: Types of Governors; Force Analysis of Porter and Hartnell Governors. Controlling Force, Stability, Sensitiveness, Isochronism, Effort and Power. Discussion on applications.

Module-5

Free vibrations: Basic elements of vibrating system, Types of free vibrations, Longitudinal vibrations- Equilibrium method, D'Alembert's principle, Determination of natural frequency of single degree freedom systems, Damped free vibrations: Under damped, over damped and critically damped systems. Logarithmic decrement.

Forced vibrations: Undamped forced vibration of spring mass system, damped forced vibrations, rotating unbalance, Reciprocating unbalance, Vibration isolation, Critical speed. Discussions on applications.

Course outcome (Course Skill Set)

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

1. Knowledge of mechanisms and their motion and the inversions of mechanisms
2. Analyse the velocity, acceleration of links and joints of mechanisms.
3. Analyse the mechanisms for static and dynamic equilibrium.
4. Carry out the balancing of rotating and reciprocating masses
5. Analyse different types of governors used in real life situation.
6. Analyze the free and forced vibration phenomenon.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the final CIE, average of best two tests for 25 marks and for the Assessment (min. two methods), there are 25 marks. Total CIE is for 50 marks
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB4.2, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two

assignments at the end of the semester if two assignments are planned.

- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment to a total mark of 50.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Text Books

1. Theory of Machines Kinematics and Dynamics Sadhu Singh Pearson Third edition 2019
2. Mechanism and Machine Theory G. Ambekar PHI 2009 Reference Books

Reference Books

1. Theory of Machines Rattan S.S Tata McGraw-Hill Publishing Company 2014
2. Mechanisms and Machines- Kinematics, Dynamics and Synthesis Michael M Stanisic Cengage Learning 2016
3. Machines and Mechanisms- David H. Myszka, 2012, Prentice Hall,

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/112/106/112106270/
- https://nptel.ac.in/courses/112105268
- https://archive.nptel.ac.in/courses/112/104/112104121/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

1. Course Seminar
2. Term project
3. Assignment

CNC PROGRAMMING AND 3-D PRINTING LAB		Semester	5th
Course Code	BME504L	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0-0-2*-0	SEE Marks	50
Credits	01	Total Marks	100
Examination nature (SEE)	Practical	Exam Hours	03 Hrs

**** Additional one hour may be considered for Instructions if required***

Course objectives:

- To expose the students to the techniques of CNC programming and cutting tool path generation through CNC simulation software by using G-Codes and M-codes.
- To educate the students on the usage of CAM packages.
- To expose the students on the usage of 3D Printing Technology
- To make the students understand the importance of automation in industries through exposure to FMS,
- Robotics, and Hydraulics and Pneumatics.

Sl.NO	Experiments
1	Manual CNC part programming using ISO Format G/M codes for 2 turning and 2 milling parts. Selection and assignment of tools, correction of syntax and logical errors, and verification of tool path using CNC program verification software.
2	CNC part programming using CAM packages : Simulation of Turning simulations to be carried out using simulation packages like: Cadem CAMLab-Pro, Master-CAM.
3	CNC part programming using CAM packages : Simulation of Drilling simulations to be carried out using simulation packages like: CademCAMLab-Pro, Master-CAM.
4	CNC part programming using CAM packages : Simulation of Milling simulations to be carried out using simulation packages like: CademCAMLab-Pro, Master-CAM.
5	Internal and external threading : Write a CNC program to create internal and external threading on a cylindrical block(s).
6	Simple 3D Printing Model : Creating Simple 3D model (example cube, gear, prism etc) in CAD software and printing the model using any 3D Printer (FDM/SLA/SLS printer)
7	Assembly Model-1: Creating an 3D CAD model of NUT and Bolt (example size M12x50), print the model using any 3D Printer and Check the assembly
8	Assembly Model-2: Creating an 3D CAD assembly model containing four or more parts (example Screw jack, plumber block etc) print the model using any 3D Printer and Check the assembly
	Demonstration Experiments (For CIE)
9	Robot programming: Using Teach Pendent & Offline programming to perform pick and place, stacking of objects (2 programs).
10	Pneumatics and Hydraulics, Electro-Pneumatics: 3 typical experiments on Basics of these topics to be conducted.
11	FMS (Flexible Manufacturing System): Programming of Automatic storage and Retrieval system (ASRS) and linear shuttle conveyor Interfacing CNC lathe, milling with loading unloading arm and ASRS to be carried out on simple components.
12	Simple strength testing of 3D Printed Parts

Course outcomes (Course Skill Set):
At the end of the course the student will be able to:

- Explain the knowledge of G-code and M-code for machining operations.
- Perform CNC programming for turning, drilling, milling and threading operation.
- Visualize the 3D models using CAD software's
- Use 3D printing technology
- **Understand robotic programming and FMS**

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation (CIE):

CIE marks for the practical course are **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners, one from other institute as external and one from the same institute as internal examiner, are appointed by the university.

- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

- https://nptel.ac.in/courses/112102103
- https://onlinecourses.nptel.ac.in/noc19_me46/preview
- https://nptel.ac.in/courses/112103306
- https://archive.nptel.ac.in/courses/112/105/112105211/
- https://onlinecourses.nptel.ac.in/noc20_me50/preview

MECHATRONICS		Semester	6
Course Code	**BME515A**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

1. To acquire a strong foundation in science and focus in mechanical, electronics, control, software, and computer engineering, and a solid command of the newest technologies.
2. To understand the evolution and development of Mechatronics as a discipline.
3. To substantiate the need for interdisciplinary study in technology education
4. To understand the applications of microprocessors in various systems and to know the functions of each element.
5. To demonstrate the integration philosophy in view of Mechatronics technology
6. To be able to work efficiently in multidisciplinary teams.

Teaching-Learning Process (General Instructions):

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint Presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Arrange visits to show the live working models other than laboratory topics.
4. Adopt collaborative (Group Learning) Learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills and develops thinking skills such as evaluating, generalizing, and analyzing information.

Module-1

Introduction: Scope and elements of Mechatronics, Mechatronics design process, measurement system, requirements and types of control systems, feedback principle, Basic elements of feedback control systems, Classification of control system. Examples of Mechatronics Systems such as Automatic Car Park system, Engine management system, Antilock braking system (ABS) control, Automatic washing machine.

Transducers and sensors: Definition and classification of transducers, Difference between transducer and sensor, Definition and classification of sensors, Principle of working and applications of light sensors, Potentiometers, LVDT, Capacitance sensors, force and pressure sensors, Strain gauges, temperature sensors, proximity switches and Hall Effect sensors.

Module-2

Signal Conditioning: Introduction – Hardware – Digital I/O, Analog to digital conversions, resolution, Filtering Noise using passive components – Registers, capacitors, amplifying signals using OP amps. Digital Signal Processing – Digital to Analog conversion, Low pass, high pass, notch filtering. Data acquisition systems DAQS), data loggers, Supervisory control and data acquisition (SCADA), Communication methods.

Electro Mechanical Drives: Relays and Solenoids – Stepper Motors – DC brushed motors – DC brushless motors – DC servo motors – 4-quadrant servo drives, PWM's – Pulse Width Modulation.

Module-3

Microprocessor & Microcontrollers: Introduction, Microprocessor systems, Basic elements of control systems, Microcontrollers, Difference between Microprocessor and Microcontrollers.

Microprocessor Architecture: Microprocessor architecture and terminology-CPU, memory and address, I/O and Peripheral devices, ALU, Instruction and Program, Assembler, Data Registers, Program Counter, Flags, Fetch cycle, write cycle, state, bus interrupts. Intel's 8085A Microprocessor.

Module-4

Programmable Logic Controller: Introduction to PLCs, Basic structure of PLC, Principle of operation, input and output processing, PLC programming language, ladder diagram, ladder diagrams circuits, timer counters, internal relays, master control, jump control, shift registers, data handling, and manipulations, analogue input and output, selection of PLC for application.

Application of PLC control: Extending and retracting a pneumatic piston using latches, control of two pneumatic pistons, control of process motor, control of vibrating machine, control of process tank, control of conveyer motor etc.

Module-5

Mechatronics in Computer Numerical Control (CNC) machines: Design of modern CNC machines – Machine Elements: Different types of guide ways, Linear Motion guide ways. Bearings: anti-friction bearings, hydrostatic bearing and hydrodynamic bearing. Re-circulating ball screws. Typical elements of open and closed loop control systems. Adaptive controllers for machine tools.

Mechatronics Design process: Stages of design process – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Automatic car park barrier.

Course outcome (Course Skill Set)

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

CO1: Illustrate various components of Mechatronics systems.

CO2: Assess various control systems used in automation.

CO3: Design and conduct experiments to evaluate the performance of a Mechatronics system or Component with respect to specifications, as well as to analyse and interpret data.

CO4: Apply the principles of Mechatronics design to product design.

CO5: Function effectively as members of multidisciplinary teams.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB4.2, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment for a total of 50 marks.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Mechatronics System Design by Devdas Shetty and Richard A Kolk, Second edition, Thomson Learning Publishing
2. Company, Vikas publishing house, 2001.
3. W. Bolton, "Mechatronics" - Addison Wesley Longman Publication, 1999.
4. Shetty and Kolk "Mechatronics System Design"- Cengage Learning, 2010

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Quiz
- Presentations
- Group Activity

Automation in Manufacturing		Semester	V
Course Code	**BME515B**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hr	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	**Theory**		

Course objectives:

- Explain the basics of productions, automation system and manufacturing operations.
- Solve the simple problems on mathematical model.
- Explain CAPP and MRP system and analyze the AGVS.
- Understand the inspection technologies and shop floor control.
- Explain the modern trends in additive manufacturing and automated factory

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1

Introduction: Production system facilities, Manufacturing support systems, Automation in production systems, Automation principles &strategies Manufacturing Operations: Manufacturing operations, Product/production relationship, Production concepts and Mathematical models &costs of manufacturing operations. Problems on mathematical models

Module-2

Line Balancing: Methods of line balancing, Numerical problems on largest candidate rule, Kilbridge's and Wester's method, and ranked positional weights method, computerized line balancing methods. Automated Assembly System: Design for automated assembly, types of automated assembly system, Parts feeding devices, Analysis of single and multi station assembly machines.

Module-3

Computerized Manufacture Planning and AGVS: Computer aided process planning (CAPP), Retrieval and Generative systems, and benefits of CAPP. Material requirement planning, Inputs to MRP system, working of MRP, Outputs and benefits. Automated Guided Vehicles System: Applications, Guidance and routing, Industrial Robotics: Definition, Robot anatomy, Joints and links, Robot configurations, Robot control systems, Accuracy and repeatability, End effectors, Sensors in robotics. Industrial robot applications: Material handling, Processing, assembly and inspection.

Module-4

Inspection Technologies: Automated inspection, coordinate measuring machines construction, Operation &programming, Software, application &benefits, Flexible inspection system, Inspection probes on machine tools, Machine vision, Optical inspection techniques & Non-contact Non-optical inspection technologies. Shop Floor Control and Automatic Identification Techniques: Shop floor control, Factory data collection system, Automatic identification methods, Bar code technology, Automatic data collection systems. An Introduction to QR Code Technology

Module-5

Additive Manufacturing Systems: Basic principles of additive manufacturing, Slicing CAD models for AM, Advantages and limitations of AM technologies, Recent trends in manufacturing, Hybrid manufacturing. Future of Automated Factory: Trends in manufacturing, the future automated factory, Human workers in future automated factory, Social impact.

Course outcome (Course Skill Set)

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

CO1: Explain the basics of productions, automation system and manufacturing operations. Solve the simple problems on mathematical model.

CO2:Explain CAPP and MRP system and analyze the AGVS.

CO3:Understand the inspection technologies and shop floor control.

CO4:Explain the modern trends in additive manufacturing and automated factory.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assessment methods mentioned in the 22OB4.2, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment for a total of 50 marks.

  Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

Text Books:

1. Automation, Production Systems and Computer-Integrated Manufacturing, by Mikell P Groover, 3rd Edition, 2009, PHI Learning.
2. Automation, Production Systems and Computer-Integrated Manufacturing, by Mikell P Groover, 1999, Prentice-Hall of India.

3. CAD / CAM Principles and Applications by P N Rao, 3rd Edition, 2015, Tata Mc Graw Hill.
4. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 2nd Ed. (2015), Ian Gibson, David W. Rosen, Brent Stucker 98
5. "Understanding Additive Manufacturing", Andreas Gebhardt, Hanser Publishers, 2011

Reference Books:

1. Systems Approach to Computer-Integrated Design and Manufacturing by Dr. Nanua Singh,Wiley, 1996.
2. CAD/CAM/CIM P. Radhakrishnan, S. Subramanyan, U. Raju, New Age International Publication Revised Third Edition 2007. Delhi.

Web links and Video Lectures (e-Resources):

http://lavalle.pl/vr/book.html
https://nptel.ac.in/courses/106/106/106106138/
https://www.coursera.org/learn/introduction-virtual-reality.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Course seminars

Supply Chain Management & Introduction to SAP		Semester	5th
Course Code	**BME515C**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	**Theory**		

Course objectives:

- To acquaint with key drivers of supply chain performance and their inter-relationships with strategy.
- To impart analytical and problem-solving skills necessary to develop solutions for a variety of supply chain management & design problems.
- To study the complexity of inter-firm and intra-firm coordination in implementing programs such as e-collaboration, quick response, jointly managed inventories and strategic alliances.
- To understand the usage of SAP material management system

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different type of teaching methods to develop the outcomes through Power-Point Presentation and Video demonstration or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Discuss the case studies and how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
4. Adopt collaborative (Group Learning) Learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information.

Module-1

Introduction: Supply Chain – Fundamentals –Evolution- Role in Economy - Importance - Decision Phases –Supplier Manufacturer-Customer chain. - Enablers/ Drivers of Supply Chain Performance. Supply chain strategy -Supply Chain Performance Measures.

Strategic Sourcing Outsourcing – Make Vs buy - Identifying core processes - Market Vs Hierarchy - Make Vs buy continuum -Sourcing strategy - Supplier Selection and Contract Negotiation.

Module-2

Warehouse Management Stores management-stores systems and procedures-incoming materials control stores accounting and stock verification Obsolete, surplus and scrap-value analysis-material handling transportation and traffic management -operational efficiency-productivity-cost effectiveness-performance measurement.

Supply Chain Network Distribution Network Design – Role - Factors Influencing Options, Value Addition – Distribution Strategies - Models for Facility Location and Capacity allocation. Distribution Center Location Models.

Module-3

Supply Chain Network optimization models. Impact of uncertainty on Network Design - Network Design, decisions using Decision trees. Planning Demand, -multiple item -multiple location inventory management. Pricing and Revenue Management.

Module-4

Current Trends: Supply Chain Integration - Building partnership and trust in Supply chain Value of Information: Bullwhip Effect - Effective forecasting - Coordinating the supply chain. Supply Chain

restructuring, Supply Chain Mapping - Supply Chain process restructuring, Postpone the point of differentiation – IT in Supply Chain - Agile Supply Chain -Reverse Supply chain. Future of IT in supply chain- EBusiness in supply chain.

Module-5

Introduction to SAP - SAP Material Management, Procurement process, Organization structure, Enterprise structure, Master data management, purchase Info record, source list, procurement cycle, purchase requisition, request for quotation, purchase order, inventory management, invoice verification, service management, transaction code

Course outcome (Course Skill Set)

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

1. Describe the framework and scope of supply chain management.
2. Build and manage a competitive supply chain using strategies, models, techniques and information technology.
3. Plan the demand, inventory and supply and optimize supply chain network.
4. Illustrate the emerging trends and impact of IT on Supply chain.
5. Apply the basics of SAP material management system

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assessment methods mentioned in the 22OB4.2, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment for a total of 50 marks.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Janat Shah, Supply Chain Management– Text and Cases, Pearson Education, 2nd edition
2. Sunil Chopra and Peter Meindl, Supply Chain Management-Strategy Planning and Operation, PHI Learning /Pearson Education, 6th edition.
3. David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi, Designing and Managing the Supply Chain: Concepts, Strategies, and Cases, Tata McGraw-Hill.
4. Ballou Ronald H, Business Logistics and Supply Chain Management, Pearson Education
5. Ashfaque Ahmed, The SAP Materials Management Handbook, CRC Press Publication. 2014 edition.
6. Martin Murray & Jawad Akhtar, Materials Management with SAP ERP: Functionality and Technical Configuration, SAP Press; Fourth edition.
7. P. Gopalakrishnan, M. Sundaresan, Materials Management: An Integrated Approach, Prentice Hall India

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc21_mg45/preview
- https://nptel.ac.in/courses/110106045
- https://www.udemy.com/course/sap-mm-training/
- https://www.udemy.com/course/sap-s4hana-mm-sourcing-and-procurement/
- https://nptel.ac.in/courses/110105095.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Case study of companies' example Amazon, Flipkart, Parle, DMart, Reliance etc can be discussed

Energy Engineering		Semester	V
Course Code	**BME515D**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	**Theory**		

Course objectives:

- Understand energy scenario, energy sources and their utilization
- Learn about energy conversion methods
- Study the principles of renewable energy conversion systems.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Arrange visits to show the live working models other than laboratory topics.
- Adopt collaborative (Group Learning) Learning in the class.
- Adopt Problem Based Learning (PBL), which foster students' Analytical skills and develops
- thinking skills such as evaluating, generalizing, and analyzing information.

Module-1

Steam Generators: Coal and ash handling, Generation of steam using forced circulation, high and supercritical pressures, LaMount, Benson, Velox, Loeffer, Schmidt steam generators, Cooling towers and Ponds, Accessories such as Super heaters, De-super heater, Economizers, Air pre heaters.

Diesel Engine Power System: Applications of Diesel Engines in Power field. Method of starting Diesel engines. Auxiliaries like cooling and lubrication system, filters, centrifuges, Oil heaters, intake and exhaust system, Layout of diesel power plant.

Module-2

Solar Energy: Introduction, Solar radiation at the earth's surface, Solar radiation measurements, Flat plate collectors, Focussing collectors, Solar Pond, Solar electric power generation-Solar photo voltaic.

Biomass Energy: Photosynthesis, photosynthetic oxygen production, energy plantation.

Biochemical Route: Biogas production from organic wastes by anaerobic fermentation, Biogas plants-KVIC, Janta, Deenbhandu models, factors affecting bio gas generation. Thermal gasification of biomass, updraft and downdraft

Module-3

Geothermal Energy: Forms of geothermal energy, Dry steam, wet steam, hot dry rock and magmatic chamber systems.

Tidal Energy: Tidal power, Site selection, Single basin and double basin systems, Advantages and disadvantages of tidal energy.

Wind Energy: Wind energy-Advantages and limitations, wind velocity and wind power, Basic components of wind energy conversion systems, horizontal and vertical axis wind mills, coefficient of performance of a wind mill rotor, Applications of wind energy.

Module-4

Hydroelectric plants: Advantages & disadvantages of water power, Hydrographs and flow duration curves numerical, Storage and pondage, General layout of hydel power plants-components such as Penstock, surge tanks, spill way and draft tube and their applications, pumped storage plants, Detailed classification of hydroelectric plants, water hammer.

Ocean Thermal Energy: Ocean thermal energy conversion, Principle and working of Rankine cycle, Problems associated with OTEC.

Module-5

Nuclear Energy: Principles of release of nuclear energy-Fusion and fission reactions. Nuclear fuels used in the reactors, Chain reaction, Moderation, breeding, Multiplication and thermal utilization factors. General components of a nuclear reactor and materials, Brief description-Pressurized water reactor, Boiling water reactor, Sodium graphite reactor, Fast Breeder reactor, Homogeneous graphite reactor and gas cooled reactor, Radiation hazards, Shielding, Nuclear waste, Radioactive waste disposal.

Course outcome (Course Skill Set)

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

CO1: Understand the construction and working of steam generators and their accessories.
CO2: Identify renewable energy sources and their utilization.
CO3: Understand principles of energy conversion from alternate sources including wind, geothermal, ocean, biomass, nuclear, hydel and tidal.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assessment methods mentioned in the 22OB4.2, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment for a total of 50 marks.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Test Books:

1. G.D. Rai, Non conventional energy resources, 5th Edition, Khanna Publishers, New Delhi
2. B H Khan, Non conventional energy resources, 3rd Edition, McGraw Hill Education
3. Principles of Energy conversion, A. W. Culp Jr., McGraw Hill. 1996

REFERENCE BOOKS

1. S.P. Sukhatme, Solar Energy: principles of Thermal Collection and Storage, Tata McGraw-Hill (1984).
2. C. S. Solanki, ―Solar Photovoltaic's: Fundamental Applications and Technologies, Prentice Hall of India, 2009.
3. L.L. Freris, Wind Energy Conversion Systems, Prentice Hall, 1990.

Web links and Video Lectures (e-Resources):

- https://www.tlv.com/global/TI/steam-theory/principal-applications-for-steam.html
- https://youtu.be/IdPTuwKEfmA
- https://youtu.be/6FMLm5WCadI
- https://youtu.be/utjf7US_cKA
- https://youtu.be/Z1ur09_SLVo
- https://youtu.be/Z1ur09_SLVo
- https://youtu.be/AMXxXoHtM-o

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

1. Visit to conventional energy source power plant (thermal power plant/nuclear power plant/diesel engine power plant)
2. Visit to Non-conventional energy source power plant (solar power plant/wind power plant/tidal power plant/OTEC power plant, etc)
3. Video demonstration of latest trends in renewable energy sources.

HEAT TRANSFER		Semester	6th
Course Code	**BME601**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
Examination nature (SEE)	Theory		

Course objectives:
Student will be able to learn

- Principles of heat transfer.
- Steady and transient heat transfer, obtain the differential equation of heat conduction in various coordinate system.
- Physical mechanism of convection and visualize the development of velocity and thermal boundary layers during flow over a surface.
- Radiation heat transfer mechanism
- The mechanisms of boiling and condensation and understand performance parameters of heat exchangers.

Teaching-Learning Process (General Instructions)
These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Adopt flipped classroom teaching method.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1

Introductory Concepts and definition: Review of basics of Modes of Heat Transfer.
Conduction-Basic Equations: General form of one-dimensional heat conduction equation. Boundary conditions of first, second and third kinds;

One dimensional Steady state conduction with and without heat generation: Steady state conduction in slab, cylinder and sphere with engineering applications.
Steady state conduction: Overall heat transfer coefficient for a composite medium; thermal contact resistance; critical thickness of insulation, Discussion on engineering applications.

MODULE-2

Extended surfaces; Steady state conduction in fins of uniform cross section long fin, fin with insulated tip and fin with convection at the tip; fin efficiency & effectiveness, Discussion on engineering applications.

One dimensional Transient conduction: Conduction in solids with negligible internal temperature gradients (lumped system analysis) Use of transient temperature charts (Heisler's charts) for Transient conduction in slab, long cylinder and sphere; Discussion on engineering applications.

MODULE-3

Numerical Analysis of Heat Conduction: Introduction, one-dimensional steady conduction and one Dimensional unsteady conduction, boundary conditions, and solution methods.

Radiation Heat transfer: Review of basic laws of thermal radiation, Intensity of radiation and solid angle; Concept of thermal radiation resistance, Radiation network, view factor, Radiation heat exchange between two parallel infinite black surfaces, between two parallel infinite gray surfaces; Effect of radiation shield; Discussion on engineering applications.

MODULE-4

Concepts and Basic Relations in Boundary layers: Flow over a flat plate -Velocity boundary layer, Thermal boundary layer; Prandtl number; general expression for local heat transfer coefficient; Average heat transfer coefficient.

Forced Convection: Physical significance of Dimensionless numbers. Use of various Correlations for hydro dynamically and thermally developed flows; Use of correlations for flow over a flat plate, cylinder, sphere and flow inside the duct.

Free or Natural Convection: Physical significance of dimensionless numbers. Use of correlations for free convection from or to vertical, horizontal and inclined flat plates, vertical and inclined cylinder.

MODULE-5

Boiling and Condensation; Pool boiling regimes. Basics of Film and dropwise condensation, Use of correlations for film and dropwise condensation on tubes.

Heat Exchangers: Classification of heat exchangers; Overall heat transfer coefficient, Fouling, Scaling factors; LMTD and NTU methods of analysis of heat exchangers.

PRACTICAL COMPONENT OF IPCC*(May cover all / major modules)*

Sl.NO	Experiments
1	Determination of Thermal Conductivity of a Metal Rod.
2	Determination of Overall Heat Transfer Coefficient of a Composite wall.
3	Determination of Effectiveness on a Metallic fin.
4	Determination of Heat Transfer Coefficient in free Convection
5	Determination of Heat Transfer Coefficient in a Forced Convention
6	Determination of Emissivity of a Surface and Determination of Stefan Boltzmann Constant.
7	Determination of LMDT and Effectiveness in a Parallel Flow and Counter Flow Heat Exchangers.
8	Experiments on Boiling of Liquid and Condensation of Vapour.
9	Experiment on Transient Conduction Heat Transfer.
10	Use of CFD for demonstrating heat transfer mechanism considering practical applications, Minimum two exercises
11	
12	Using one dimensional transient conduction, experimentally demonstrate estimation of thermal conductivity and thermal diffusivity

Course outcomes (Course Skill Set):

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

- Determine temperature distribution in steady-state heat conduction.
- Analyse the forced and free convective heat transfer.
- Analyse the radiation Heat transfer. Analyse the heat transfer through extended surfaces and

transient heat conduction.

- Design of heat exchangers using LMTD, NTU methods and analyse the boiling and condensation.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student must secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**)

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored by the student shall be proportionally scaled down to 50 Marks

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper may include questions from the practical component.

Suggested Learning Resources:
(Title of the Book/Name of the author/Name of the publisher/Edition and Year)
Text Books:

1. Principals of heat transfer Frank Kreith, Raj M. Manglik, Mark S. Bohn Cengage learning Seventh Edition 2011.
2. Heat transfer, a practical approach Yunus A. Cengel Tata Mc Graw Hill Fifth edition

Reference Books:

1. Heat and mass transfer Kurt C, Rolle Cengage learning second edition
2. Heat Transfer A Basic Approach M. Necati Ozisik McGraw Hill, New York 2005
3. Fundamentals of Heat and Mass Transfer Incropera, F. P. and De Witt, D. P John Wiley and Sons, New York 5thEdition 2006
4. Heat Transfer Holman, J. P. Tata McGraw Hill, New York 9th Edition 2008

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=rxTK_SvSmvs&list=PL1gyM10tgL1hK9666oGndGlWDQdpQzkY9
- https://www.kochheattransfer.com/products/twisted-tube-bundle-technology?gad=1&gclid=Cj0KCQjwmtGjBhDhARIsAEqfDEdG22TY7OHa8PBzHX1Yo_DKQcheV46aZxtDRvDIhCe1Gfpr5obDMLoaArSXEALw_wcB
- https://www.hightemp-furnaces.com/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Organize a visit to automobile service station and write a report for cooling systems in automobile.
- Apply knowledge of plane wall transient conduction to determine the temperature distribution throughout the pizza as a function of time.

MACHINE DESIGN		Semester	6th
Course Code	**BME602**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3-2-0-0	SEE Marks	50
Total Hours of Pedagogy	52	Total Marks	100
Credits	04	Exam Hours	3
Examination type (SEE)	**Theory**		

Course objectives:

The student will be able:

1. To explain the principles involved in design of machine elements, subjected to different kinds of forces, from the considerations of strength, rigidity.
2. To understand and interpret different failure modes and application of appropriate criteria for design of machine elements.
3. Develop the capability to design elements like shafts, couplings and welded joints, screwed joints.
4. To learn transmission elements like gears, belts, pulleys, bearings from the manufacturers' catalogue.
5. To produce assembly and working drawings of various mechanical systems involving machine elements like clutches and brakes.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Adopt flipped classroom teaching method.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1

Introduction and Review: Review of engineering materials and their properties and manufacturing processes; use of codes and standards, selection of preferred sizes. Review of axial, bending, shear and torsion loading on machine components, combined loading.

Design for static strength: Factor of safety and service factor. Failure mode: definition and types., Failure of brittle and ductile materials; even and uneven materials; Stress concentration, stress concentration factor, Theories of failure: maximum normal stress theory, maximum shear stress theory, distortion energy theory, strain energy theory, Columba –Mohr theory and modified Mohr's theory

Fatigue loading: Introduction to fatigue failure, Mechanism of fatigue failure, types of fatigue loading, S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit.

Module-2

Design of shafts: Torsion of shafts, solid and hollow shaft design with steady loading based on strength and rigidity, ASME and BIS codes for power transmission shafting, design of shafts subjected to combined bending, torsion and axial loading, Discussion on engineering applications.

Design of keys and couplings: Keys: Types of keys and their applications, design considerations in parallel and tapered sunk keys, Design of square and rectangular sunk keys. Couplings: Rigid and flexible coupling-types and applications, design of Flange coupling, and Bush and Pin type coupling.

Module-3

Riveted joints: Types of rivets, rivet materials, Caulking and fullering, analysis of riveted joints, joint efficiency, failures of riveted joints, boiler joints, riveted brackets, Discussion on engineering applications.

Welded joints: Types, strength of butt and fillet welds, eccentrically loaded welded joints, Discussion on engineering applications.

Spur Gears: Definitions, stresses in gear tooth: Lewis equation and form factor, design for strength, dynamic load and wear.

Module-4

Helical Gears: Definitions, transverse and normal module, formative number of teeth, design based on strength,dynamic load and wear.

Bevel Gears: Definitions, formative number of teeth, design based on strength, dynamic load and wear.

Worm Gears: Definitions, types of worm and worm gears, and materials for worm and worm wheel. Design based onstrength, dynamic, wear loads and efficiency of worm gear drives.

Module-5

Design of Clutches and Brakes: Design of single plate, multi-plate based on uniform pressure and uniform wear theories. Design of band brakes, block brakes

Lubrication and Bearings: Lubricants and their properties, bearing materials and properties; mechanisms of lubrication, hydrodynamic lubrication, pressure development in oil film, bearing modulus, coefficient of friction, minimum oil film thickness, heat generated, and heat dissipated.

Course outcome (Course Skill Set)

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

1. Apply codes and standards in the design of machine elements and select an element based on the Manufacturer's catalogue.
2. Analyse the performance and failure modes of mechanical components subjected to combined loading and fatigue loading using the concepts of theories of failure.
3. Demonstrate the application of engineering design tools to the design of machine components like shafts, keys, couplings, welded and riveted joints, brakes and clutches
4. Design different types of gears and simple gear boxes for relevant applications.
5. Apply design concepts of hydrodynamic bearings for different applications using the manufacturers, catalogue.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assessment methods mentioned in the 22OB4.2, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment for a total of 50 marks.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Text Books

1 Shigley's Mechanical Engineering Design Richard G. Budynas, and J. Keith Nisbett McGraw-Hill Education 10th Edition,2015

2 Fundamentals of Machine Component Design Juvinall R.C, and Marshek K.M John Wiley & Sons Third Edition 2007Wiley student edition

3 Design of Machine Elements V. B. Bhandari Tata Mcgraw Hill 4th Ed 2016.

Web links and Video Lectures (e-Resources):

1. https://en.wikipedia.org/wiki/Machine_element
2. www.nptel.ac.in
3. https://cosmolearning.org
4. www.vtu.ac.in
5. http://nevonprojects.com/mini-projects-for-mechanical-engineering/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning:

- Term Projects
- Course seminar

Design lab		Semester	6th
Course Code	**BME606L**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0-0-2	SEE Marks	50
Credits	01	Exam Hours	3
Examination type (SEE)	Practical		

Course objectives:

The students will be able

- To understand the concepts of natural frequency, logarithmic decrement, damping and damping ratio.
- To understand the techniques of balancing of rotating masses and influence of gyroscopic couple.
- To verify the concept of the critical speed of a rotating shaft.
- To illustrate the concept of stress concentration using Photo elasticity.
- To appreciate the equilibrium speed, sensitiveness, power and effort of a Governor.
- To illustrate the principles of pressure development in an oil film of a hydrodynamic journal bearing.
- To visualize different mechanisms and cam motions
- Modern computing techniques are preferred to be used wherever possible

Sl.NO	Experiments
1	Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems (longitudinal and torsional)
2	Balancing of rotating masses
3	Determination of critical speed of a rotating shaft
4	Determination of equilibrium speed, sensitiveness, power and effort of Porter/Proell /Hartnell Governor.
5	Determination of Pressure distribution in Journal bearing
6	Study of different types of cams, types of followers and typical follower motions. Obtain cam profile for any two types of follower motions and types of followers
7	
8	Determination of Fringe constant of Photo-elastic material using. a) Circular disc subjected to diametral compression. b) Pure bending specimen (four-point bending).
	Demonstration Experiments (For CIE)
9	Study the principle of working of a Gyroscope and demonstrate the Effect of gyroscopic Couple on plane disc
10	Demonstration and study of operation of different Mechanisms and their Inversions: Slider crank chain, Double slider crank chain and its inversions, Quick return motion mechanisms- Peaucellier's mechanism. Geneva wheel mechanism, Ratchet and Pawl mechanism, toggle mechanism, pantograph, Ackerman steering gear mechanism
11	
12	Demonstration of stress concentration using Photo-elasticity for simple components like plate with a hole under tension or bending, circular disk with circular hole under compression

Course outcomes (Course Skill Set):

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

- Compute the natural frequency of the free and forced vibration of single degree freedom systems, critical speed of shafts.

- Carry out balancing of rotating masses and gyroscope phenomenon.
- Analyse the governor characteristics.
- Determine stresses in disk, beams and plates using photo elastic bench.
- Determination of Pressure distribution in Journal bearing
- Analyse the stress and strains using strain gauges in compression and bending test
- To realize different mechanisms and cam motions

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation (CIE):

CIE marks for the practical course are**50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners, one from other institute as external and one from the same institute as internal examiner, are appointed by the university.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics

shall be decided jointly by examiners.

- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

- Theory of Machines, Rattan S.S , Tata McGraw-Hill Publishing Company, 2014 2. Experimental Stress analysis, M. M. Frotch, McGraw-Hill

TOTAL QUALITY MANAGEMENT		Semester	6th
Course Code	**BME613A**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3-0-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory/practical/Viva-Voce /Term-work/Others		

Course objectives:

- Understand various approaches to TQM
- Understand the characteristics of quality leader and his role.
- Develop feedback and suggestion systems for quality management.
- Enhance the knowledge in Tools and Techniques of quality management•

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills
- such as evaluating, generalizing, and analysing information.

Module-1

Principles and Practice:

- Definition, basic approach, gurus of TQM, TQM Framework, awareness, defining quality, historical review, obstacles, benefits of TQM.
- Quality Management Systems: Introduction, benefits of ISO registration, ISO 9000 series of standards, ISO 9001 requirements.

Module-2

Leadership:

- Definition, characteristics of quality leaders, leadership concept, characteristics of effective people, ethics, the Deming philosophy,
- Role of TQM leaders, implementation, core values, concepts and framework, strategic planning communication, decision making,

Module-3

Customer Satisfaction and Customer Involvement:

- Customer Satisfaction: customer and customer perception of quality, feedback, using customer complaints, service quality, translating needs into requirements, customer retention, case studies.
- Employee Involvement – Motivation, employee surveys, empowerment, teams, suggestion system, recognition and reward, gain sharing, performance appraisal, unions and employee involvement, case studies.

Module-4

Continuous Process Improvement:

- The Juran trilogy, improvement strategies, types of problems, the PDSA Cycle, problem-solving methods, Kaizen, reengineering, six sigma, case studies.
- Statistical Process Control: Pareto diagram, process flow diagram, cause and effect diagram, check sheets, histograms, statistical fundamentals, Control charts, state of control, out of control process, control charts for variables, control charts for attributes, scatter diagrams, case studies.

Module-5

Total Productive Maintenance (TPM):

- Definition, Types of Maintenance, Steps in introduction of TPM in an organization, Pillars of TPM – 5S, Jishu Hozen, Quality Maintenance, Planned Maintenance.
- Quality by Design (QbD): Definition, Key components of QbD, Role of QbD in Pharmaceutical Industry, Benefits and Challenges of QbD. Environmental Management Systems (EMS): Definition, Basic EMS, EMS under ISO 14001, Costs and Benefits of EMS.

Course outcome (Course Skill Set)

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

CO1: Explain the various approaches of TQM

CO2: Infer the customer perception of quality

CO3: Analyse customer needs and perceptions to design feedback systems.

CO4: Apply statistical tools for continuous improvement of systems

CO5: Apply the tools and technique for effective implementation of TQM.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assessment methods mentioned in the 22OB4.2, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment for a total of 50 marks.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Total Quality Management Dale H. Besterfield Pearson Education India, Edition 03. ISBN: 8129702606,

2. Total Quality Management for Engineers M. Zairi Wood head Publishing ISBN:185573024
3. Managing for Quality and Performance Excellence James R. Evans and William M Lindsay Cengage Learning. 9th edition
4. Four revolutions in management Shoji Shiba, Alan Graham, David Walden Oregon 1990
5. Organizational Excellence through TQM H. Lal New age Publications 200864 Engineering Optimization Methods and Applications A Ravindran, K, M. Ragsdell Willey India Private Limited 2nd Edition,2006
6. Introduction to Operations Research- Concepts and Cases F.S. Hillier. G.J. Lieberman Tata McGraw Hill 9th Edition, 2010

Web links and Video Lectures (e-Resources):

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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Case studies Quiz
- Topic Seminar presentation
- Assignments

REFRIGERATION AND AIR CONDITIONING		Semester	VI
Course Code	**BME613B**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		

Course Learning Objectives:

1. Study the basic definition, ASHRAE Nomenclature for refrigerating systems.
2. Understand the working principles and applications of different types of refrigeration systems.
3. Study the working of air conditioning systems and their applications.
4. Identify the performance parameters and their relations of an air conditioning system.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Classroom Teaching using Pedagogical methods.
2. Using ICT tools
3. Video of different refrigeration systems and air conditioning systems.
4. Visiting industries for understanding different air conditioning systems and also the refrigerator manufacturing units.

Module-1

Introduction to Refrigeration –Basic Definitions, ASHRAE Nomenclature, Air Refrigeration Cycles-reversed Carnot cycle, Bell-Coleman cycle analysis, Air Refrigeration systems-merits and demerits and applications; Aircraft refrigeration cycles, Joule Thompson coefficient and Inversion Temperature, Linde, Claude and Stirling cycles for liquefaction of air.

Industrial Refrigeration-Chemical and process industries, Dairy plants, Petroleum refineries, Food processing and food chain, Miscellaneous

Module-2

Vapour Compression Refrigeration System(VCRS): Comparison of Vapour Compression Cycle and Gas cycle, Vapour Compression Refrigeration system Working and analysis, Limitations, Superheat horn and throttling loss for various refrigerants, efficiency, Modifications to standard cycle – liquid suction heat exchangers, Grindlay cycle and Lorenz cycle, Optimum suction condition for optimum COP – Ewing's construction and Gosney's method. Actual cycles with pressure drops, Complete Vapour Compression Refrigeration System, Multi-Pressure, Ulti-evaporator systems or Compound Vapour Compression Refrigeration Systems – Methods like Flash Gas removal, Flash inter cooling and water Inter cooling.

Module-3

Vapour Absorption Refrigeration Systems: Absorbent – Refrigerant combinations, Water-Ammonia Systems, Practical problems, Lithium- Bromide System, Contrast between the two systems, Modified Version of Aqua-Ammonia System with Rectifier and Analyzer Assembly. Practical problems – crystallization and air leakage, Commercial systems.

Other types of Refrigeration systems: Brief Discussion on (i) Steam-Jet refrigeration system and (ii) Thermoelectric refrigeration, pulse tube refrigeration, thermoacoustic refrigeration systems

Module-4

Refrigerants: Primary and secondary refrigerants, Designation of Refrigerants, Desirable properties of refrigerants including solubility in water and lubricating oil, material compatibility, toxicity, flammability, leak detection, cost, environment and performance issues Thermodynamic properties of refrigerants, Synthetic and natural refrigerants, Comparison between different refrigerants vis a vis applications, Special issues and practical implications Refrigerant mixtures – zeotropic and azeotropic mixtures.

Refrigeration systems Equipment: Compressors, Condensers, Expansion Devices and Evaporators, A brief look at other components of the system.

Module-5

Air-Conditioning: Introduction to Air-Conditioning, Basic Definition, Classification, power rating, Mathematical Analysis of Air-Conditioning Loads, Related Aspects, Different Air-Conditioning Systems-Central – Station Air-Conditioning System, Unitary Air-Conditioning System, Window Air-Conditioner and Packaged Air-Conditioner, Components related to Air-Conditioning Systems.

Transport air conditioning Systems: Air conditioning systems for automobiles (cars, buses etc.), Air conditioning systems for trains, Air conditioning systems for ships

Course outcome (Course Skill Set)

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

CO1: Understand the principles, nomenclature and applications of refrigeration systems.

CO2: Explain vapour compression refrigeration system and identify methods for performance improvement

CO3: Illustrate the working principles of air, vapour absorption, thermoelectric and steam-jet and thermoacoustic refrigeration systems.

CO4: Estimate the performance of air-conditioning systems using the principles of psychrometry.

CO5: Compute and Interpret cooling and heating loads in an air-conditioning system.

CO6: Identify suitable refrigerant for various refrigerating systems.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assessment methods mentioned in the 22OB4.2, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment for a total of 50 marks.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Text Books

1. Roy J. Dossat, Principles of Refrigeration, Wiley Limited
2. Arora C.P., Refrigeration and Air-conditioning, Tata Mc Graw –Hill, New Delhi, 2ndEdition, 2001.
3. Stoecker W.F., and Jones J.W., Refrigeration and Air-conditioning, Mc Graw - Hill, New Delhi 2nd edition, 1982.

Reference Books:

1. Dossat, Principles of Refrigeration Pearson-2006.
2. McQuistion, Heating, Ventilation and Air Conditioning, Wiley Students edition,5th edition, 2000.
3. Refrigeration and Air-Conditioning' by Manohar prasad
4. S C Arora& S Domkundwar, Refrigeration and Air-Conditioning Dhanpat Rai Publication

Web links:

http://nptel.ac.in/courses/112105128/#

MEMS & MICROSYSTEM TECHNOLOGY		Semester	VI
Course Code	**BME613C**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3-0-0-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory/practical/Viva-Voce /Term-work/Others		

Course objectives:

1. Students are exposed to the MEMS technology & Miniaturization.
2. Students are taught the Process of Micro fabrication Techniques.
3. Students are made to understand the Operation of Microsystems**.**
4. Students are made to understand the Operation Electronics Circuits for Micro and Smart Systems.
5. Students are made to understand the Implementation of Controllers for MEMS & Case Studies of Integrated Microsystems.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Power Point Presentation,
2. Chalk and Talk are used for Derivations and Correlations (In-general).
3. Video demonstration or Simulations,

Module-1

Introduction to Micro and Smart systems: Miniaturization, Microsystems versus MEMS, Micro-fabrication, Smart Materials, Structures & Systems, Integrated Microsystems, Application of Smart Materials & Microsystems.

Module-2

Micro and Smart Devices and Systems: Principles and Materials: Definitions and salient features of sensors, actuators, and systems,

Sensors: silicon capacitive accelerometer, piezoresistive pressure sensor, Portable blood analyser, conductometric gas sensor.

Actuators: Micro mirror Array for Video Projection, Piezo-electric based inkjet print head, electrostatic comb-drive, Magnetic micro relay.

Module-3

Micromachining Technologies: Silicon as a Material for Micromachining, Silicon wafer preparation, thin-film deposition techniques, Lithography, Etching, Silicon micromachining: surface micromachining bulk micromachining. Specialized Materials for Microsystems.

Module-4

Electronics Circuits for Micro and Smart Systems. Semiconductor devices: Diode, Schottky diode, Tunnel diode ,MOSFET,CMOS circuits ,Electronics Amplifiers ,Op-Amp based circuits .

Module-5

Implementation of Controllers for MEMS & Case Studies of Integrated Microsystems. Design Methodology, PID controller, Circuit Implementation, Digital controller, Microcontroller & PLC. Case Studies of Integrated Microsystems: BEL pressure sensor, design considerations, performance parameters, Smart Structure in vibration control.

Course outcome (Course Skill Set)

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

1. Demonstrate the working methodology of smart materials, Microsystems, electronic circuitry in MEMS devices.
2. Illustrate the process of silicon wafer preparation, thin film deposition techniques, lithography, etching, bulk & surface micromachining involved in MEMS fabrication.
3. Examine the behaviour of piezoresistive & piezoelectric materials required to fabricate pressure sensor & vibration control structures.
4. Measure the performance of pressure sensor & vibration control structure in real time applications.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assessment methods mentioned in the 22OB4.2, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment for a total of 50 marks.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Micro and Smart Systems: G.K.Ananthasuresh, K.J.Vinoy, S.Gopalakrishnan, K.N.Bhat, V.K.Aatre,Wiley India 2010.
2. Design and Development Methodologies, Smart Material Systems and MEMS: V. Varadan,K. J. Vinoy, S. Goplakrishnan, Wiley.
3. MEMS- Nitaigour Premchand Mahalik, TMH 2007.

4. MEMS & Microsystems: Design and Manufacture, Tai-Ran Hsu, Tata Mc-Graw-Hill

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Conduct Analysis of Stress and Strain on Cantilever beam structure on Ansys Tool.
- Prepare Models to exhibit FCC Structures and create patterns on sheets of paper to demonstrate different Micromachining Fabrication Processes.

Design for Manufacturing and Assembly		Semester	VI
Course Code	**BME613D**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	42	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

1. Understand the concepts of Geometric dimensioning and Tolerances in Engineering drawing
2. Analyse the process capabilities and datum features in various components
3. Evaluate the design considerations of casting, injection moulding, die casting and powder metallurgical components
4. Estimate the assembly limits, machining sequence and process parameters

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Classroom Teaching
2. Dissemble a machine and reassemble appreciate the fitting tolerance
3. Case studies to discuss on material selection and tolerances
4. Video of different manufacturing process
5. Videos of different assembly

Module-1 : Introduction to Design for Manufacturing

Introduction: History of DFM, Design philosophy steps in Design process - General Design rules for manufacturability - basic principles of designing for economical production - creativity in design. evaluation method, Process capability.

Materials: Selection of Materials for design Developments in Material technology - criteria for material selection

Module-2: Components design for Manufacturing

Component Design-I: Machining Consideration: Design features to facilitate machining: drills, milling cutters, keyways, Doweling procedures, counter sunk screws, Reduction of machined area, simplification by separation, simplification by amalgamation, Design for machinability, Design for economy, Design for clampability, Design for accessibility, Design for assembly.

Component Design-II: Casting Consideration: Redesign of castings based on parting line considerations, Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design, Modifying the design, group technology, Computer Applications for DFMA

Module-3: Assembly

Assemble advantages: Development of the assemble process, choice of assemble method assemble advantages social effects of automation.

Automatic assembly transfer systems: Continuous transfer, intermittent transfer, indexing mechanisms, and operator - paced free – transfer machine

GD&T – Symbols, Three datum concept of dimensioning, Straightness, concentricity, Run-out, Location Tolerance, Assembly of parts having concentric cylinders, Control of feature location by true position, Body of revolution, Roundness, Profile dimensioning, Tapers, Shaft of two diameters. Examples.

Module-4 : Manual Assembly

Design of manual assembly: Design for assembly fits in the design process, general design guidelines for manual assembly, development of the systematic DFA methodology, assembly efficiency, classification system for manual handling, classification system for manual insertion and fastening, effect of part symmetry on handling time, effect of part thickness and size on handling time, effect of weight on handling time, parts requiring two hands for manipulation, effects of combinations of factors, effect of symmetry effect of chamfer design on insertion operations, estimation of insertion time

Module-5 : Design for Environment

Design for the Environment: Introduction, Environmental objectives, Global issues, Regional and local issues, Basic DFE methods, Design guide lines, Example application, Lifecycle assessment, Basic method, Environmentally responsible product assessment, Weighted sum assessment method, Lifecycle assessment method, Techniques to reduce environmental impact, Design to minimize material usage, Design for disassembly, Design for recyclability, Design for remanufacture, Design for energy efficiency, Design to regulations and standard.

Course outcome (Course Skill Set)

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

1. Apply the concepts of Geometrical dimensioning, selection of materials and tolerance for engineering products
2. Analyse the design principles related to various manufacturing processes and assembly method
3. Develop the appropriate material and machining sequence for manufacturing processes
4. Select a suitable manufacturing system considering environmental factors

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assessment methods mentioned in the 22OB4.2, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment for a total of 50 marks.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Text Books

1. Designing for Manufacture, Peck H, Pitman Publications, 1983
2. Engineering Design: A Materials and processing Approach, Dieter, G.E. McGraw Hill Co.Ltd 2000
3. Engineering Metrology, R K Jain, Khanna Publications, 2000.

Reference Books:

1. ASM Hand book, Vol.20. Material selection & Design
2. Handbook of Products Design for Manufacturing: A Practical Guide to Low-cost Production Bralla, James G. McGraw Hill, New York, 1986.
3. Product Design for Manufacture and Assembly, Geoffery Boothroyed et al, Mercel Dekker Inc. New York.

PROJECT MANAGEMENT		Sem	6th
Course Code	**BME654A**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning Objectives:

- To understand how to break down a complex project into manageable segments and use of effective project management tools and techniques to arrive at solution and ensure that the project meets its deliverables and is completed within budget and on schedule.
- To impart knowledge on various components, phases, and attributes of a project.
- To prepare students to plan, develop, lead, manage, and successfully implement and deliver projects within their chosen practice area.

MODULE-1

Introduction: Definition of project, characteristics of projects, understand projects, types of projects, scalability of project tools, project roles **Project Selection and Prioritization** – Strategic planning process, Strategic analysis, strategic objectives, portfolio alignment – identifying potential projects, methods of selecting projects, financial mode / scoring models to select projects, prioritizing projects, securing and negotiating projects.

MODULE-2

Planning Projects: Defining the project scope, Project scope checklist, Project priorities, Work Breakdown Structure (WBS), Integrating WBS with organisation, coding the WBS for the information system.

Scheduling Projects: Purpose of a project schedule, historical development, how project schedules are limited and created, develop project schedules, uncertainty in project schedules, Gantt chart.

MODULE-3

Resourcing Projects: Abilities needed when resourcing projects, estimate resource needs, creating staffing management plant, project team composition issues, Budgeting Projects: Cost planning, cost estimating, cost budgeting, establishing cost control.

Project Risk Planning: Risk Management Planning, risk identification, risk analysis, risk response planning, Project Quality Planning and Project Kick off: Development of quality concepts, project quality management plan, project quality tools, kicks off project, baseline and communicate project management plan, using Microsoft Project for project baselines.

MODULE-4

Performing Projects: Project supply chain management: - Plan purchasing and acquisitions, plan contracting, contact types, project partnering and collaborations, project supply chain management.

Project Progress and Results: Project Balanced Scorecard Approach, Internal project, customer, financial issues, Finishing the project: Terminate project early, finish projects on time, secure customer feedback and approval, knowledge management, perform administrative and contract closure.

MODULE 5

Network Analysis: Introduction, network construction - rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method (CPM) to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project; crashing of simple projects.

Course outcomes (Course Skill Set):

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

CO1: Understand the selection, prioritization and initiation of individual projects and strategic role of project management.

CO2: Understand the work breakdown structure by integrating it with organization.
CO3: Understand the scheduling and uncertainty in projects.
CO4: Understand risk management planning using project quality tools.
CO5: Understand the activities like purchasing, acquisitions, contracting, partnering and elaborations related to performing projects.
CO6: Determine project progress and results through balanced scorecard approach
CO7: Draw the network diagram to calculate the duration of the project and reduce it using crashing.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assessment methods mentioned in the 22OB4.2, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment for a total of 50 marks.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Project Management, Timothy J Kloppenborg, Cengage Learning, Edition 2009.
2. Project Management, A systems approach to planning scheduling and controlling by Harold kerzner, CBS publication.
3. Project Management by S Choudhury, Mc Graw Hill Education (India) Pvt. Ltd. New Delhi, 2016

Reference Books:

1. Project Management, Pennington Lawrence, Mc Graw hill
2. Project Management, A Moder Joseph and Phillips New Yark Van Nostrand, Reinhold.
3. Project Management, Bhavesh M. Patal, Vikas publishing House,

Renewable Energy Power Plants		Semester	6th
Course Code	**BME654B**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

- To explore society's present needs and future energy demands.
- To introduce the concepts of solar energy
- To introduce the concepts and applications of Wind energy, Biomass energy, geothermal energy and Ocean energy as alternative energy sources.
- To get exposed to energy conservation methods.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Use pie chart showing distribution of renewable energy sources
2. Use wind turbine models
3. Use sun path diagrams

Module-1

Introduction to Renewable Energy: Overview of global energy demand and the need for renewable energy, Comparison of renewable and non-renewable energy sources, Environmental benefits and challenges of renewable energy. **Solar Radiation**: Extra-Terrestrial radiation, spectral distribution of extra-terrestrial radiation, solar constant, solar radiation at the earth's surface, beam, diffuse and global radiation

Module-2

Solar Power Plants:

Measurement of Solar Radiation: Pyrometer, shading ring pyrheliometer, sunshine recorder, schematic diagrams and principle of working. Solar Thermal Conversion: Collection and storage, thermal collection devices.

Fundamentals of solar energy and photovoltaic (PV) technology, Types of solar power plants: grid-tied, off-grid, and hybrid systems, Design considerations for solar power plants: site selection, orientation, and shading analysis, PV system components and their functionalities, Operation, maintenance, and performance monitoring of solar power plants

Module-3

Wind Power Plants:

Basics of wind energy and wind turbine technology, Types of wind turbines: horizontal axis and vertical axis; Wind resource assessment and site selection for wind power plants, Wind farm layout optimization and wake effects, Grid integration and power system considerations for wind power plants

Geothermal Energy Conversion: Principle of working, types of geothermal station with schematic diagram, geothermal plants in the world, problems associated with geothermal conversion, scope of geothermal energy.

Module-4

Tidal Power: Tides and waves as energy suppliers and their mechanics; fundamental characteristics of tidal power, harnessing tidal energy, advantages and limitations.

Ocean Thermal Energy Conversion: Principle of working, OTEC power stations in the world, problems associated with OTEC.

Module-5

Biomass Power Plants: Biomass as a renewable energy source: types and characteristics, Conversion technologies: combustion, gasification, and anaerobic digestion, biomass feedstock selection and availability, Environmental impacts and sustainability of biomass power plants, Integration of biomass power plants with other energy systems

Hydrogen Energy: Properties of Hydrogen with respected to its utilization as a renewable form of energy, sources of hydrogen, production of hydrogen, electrolysis of water, thermal decomposition of water, thermos Chemical production bio-chemical production.

Course outcome (Course Skill Set)

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

1. Understand the need of renewable energy resources, historical and latest developments.
2. Describe the use of solar energy and the various components used in the energy production
3. Appreciate the need of Wind Energy and the various components used in energy generation and
   the classifications.
4. Acquire the knowledge of fuel cells, wave power, tidal power and geothermal principles and Applications.
5. Understand the concept of Biomass energy resources and their classification, types of biogas Plants applications

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assessment methods mentioned in the 22OB4.2, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment for a total of 50 marks.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Nonconventional Energy sources, G D Rai, Khanna Publication, Fourth Edition,
2. Energy Technology, S.Rao and Dr. B.B. Parulekar, Khanna Publication. Solar energy, Subhas P Sukhatme, TataMcGrawHill, 2ndEdition,1996
3. Principles of Energy conversion, A.W.Culp Jr. McGraw Hill, 1996
4. 4. Non-Convention Energy Resources, ShobhNath Singh, Pearson, 2018

Web links and Video Lectures (e-Resources):

- https://www.investopedia.com/terms/i/internet-energy
- E-book URL: https://www.pdfdrive.com/non-conventional-energy-sources-e10086374.html
- E-book URL: https://www.pdfdrive.com/non-conventional-energy-systems-nptel-d17376903.html
- E-book URL: https://www.pdfdrive.com/renewable-energy-sources-and-their-applications-e33423592.html
- E-book URL: https://www.pdfdrive.com/lecture-notes-on-renewable-energy-sources-e34339149.
- html https://onlinecourses.nptel.ac.in/noc18_ge09/preview

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Visit nearest power plants and know the principles of power production
- Seminar/poster presentation of all Renewable power plants
- Assignments
- quiz

Introduction to MECHATRONICS		Semester	6th
Course Code	**BME654C**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

1. To acquire a strong foundation in science and focus in mechanical, electronics, control, software, and computer engineering, and a solid command of the newest technologies.
2. To understand the evolution and development of Mechatronics as a discipline.
3. To substantiate the need for interdisciplinary study in technology education
4. To understand the applications of microprocessors in various systems and to know the functions of each element.
5. To demonstrate the integration philosophy in view of Mechatronics technology
6. To be able to work efficiently in multidisciplinary teams.

Teaching-Learning Process (General Instructions):

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint Presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Arrange visits to show the live working models other than laboratory topics.
4. Adopt collaborative (Group Learning) Learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills and develops thinking skills such as evaluating, generalizing, and analyzing information.

Module-1

Introduction: Scope and elements of Mechatronics, Mechatronics design process, measurement system, requirements and types of control systems, feedback principle, Basic elements of feedback control systems, Classification of control system. Examples of Mechatronics Systems such as Automatic Car Park system, Engine management system, Antilock braking system (ABS) control, Automatic washing machine.

Transducers and sensors: Definition and classification of transducers, Difference between transducer and sensor, Definition and classification of sensors, Principle of working and applications of light sensors, Potentiometers, LVDT, Capacitance sensors, force and pressure sensors, Strain gauges, temperature sensors, proximity switches and Hall Effect sensors.

Module-2

Signal Conditioning: Introduction – Hardware – Digital I/O, Analog to digital conversions, resolution, Filtering Noise using passive components – Registers, capacitors, amplifying signals using OP amps. Digital Signal Processing – Digital to Analog conversion, Low pass, high pass, notch filtering. Data acquisition systems DAQS), data loggers, Supervisory control and data acquisition (SCADA), Communication methods.

Electro Mechanical Drives: Relays and Solenoids – Stepper Motors – DC brushed motors – DC brushless motors – DC servo motors – 4-quadrant servo drives, PWM's – Pulse Width Modulation.

Module-3

Microprocessor & Microcontrollers: Introduction, Microprocessor systems, Basic elements of control systems, Microcontrollers, Difference between Microprocessor and Microcontrollers.

Microprocessor Architecture: Microprocessor architecture and terminology-CPU, memory and address, I/O and Peripheral devices, ALU, Instruction and Program, Assembler, Data Registers, Program Counter, Flags, Fetch cycle, write cycle, state, bus interrupts. Intel's 8085A Microprocessor.

Module-4

Programmable Logic Controller: Introduction to PLCs, Basic structure of PLC, Principle of operation, input and output processing, PLC programming language, ladder diagram, ladder diagrams circuits, timer counters, internal relays, master control, jump control, shift registers, data

handling, and manipulations, analogue input and output, selection of PLC for application.
Application of PLC control: Extending and retracting a pneumatic piston using latches, control of two pneumatic pistons, control of process motor, control of vibrating machine, control of process tank, control of conveyer motor etc.

Module-5

Mechatronics in Computer Numerical Control (CNC) machines: Design of modern CNC machines – Machine Elements: Different types of guide ways, Linear Motion guide ways. Bearings: anti-friction bearings, hydrostatic bearing and hydrodynamic bearing. Re-circulating ball screws. Typical elements of open and closed loop control systems. Adaptive controllers for machine tools.
Mechatronics Design process: Stages of design process – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Automatic car park barrier.

Course outcome (Course Skill Set)
At the end of the course, the student will be able to :

CO1: Illustrate various components of Mechatronics systems.
CO2: Assess various control systems used in automation.
CO3: Design and conduct experiments to evaluate the performance of a Mechatronics system or Component with respect to specifications, as well as to analyse and interpret data.
CO4: Apply the principles of Mechatronics design to product design.
CO5: Function effectively as members of multidisciplinary teams.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB4.2, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Mechatronics System Design by Devdas Shetty and Richard A Kolk, Second edition, Thomson Learning Publishing
2. Company, Vikas publishing house, 2001.
3. W. Bolton, "Mechatronics" - Addison Wesley Longman Publication, 1999.
4. Shetty and Kolk "Mechatronics System Design"- Cengage Learning, 2010

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Quiz
- Presentations
- Group Activity

MODERN MOBILITY		Semester	VI
Course Code	**BME654D**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination nature (SEE)	Theory/practical/Viva-Voce /Term-work/Others		

Course objectives:

- To understand the different chassis design & main components of automobile
- To understand the working of transmission and control system employed in automobiles
- To understand the automotive pollution and alternative automotive technologies under trail
- To understand the upcoming electric vehicle technology

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

- Explain clearly through Power Point presentations
- showing live Videos for working of components
- Demonstration of live working of components through cut section models
- Inspecting live vehicles
- Visiting nearby service centres
- Expert Talks

Module-1 Mobility Systems

History of Automobile, Classification of Automobile w.r.t Usage, Chassis, Body, Power Sources, capacity, main components of Internal Combustion Engines and their Functions, Modern Fuel supply system, Cooling System, Lubrication System & Ignition System, Engine Management System.

Module-2 Power Transmission

Clutches; Plate Clutches, Cone Clutch, Centrifugal Clutch, Fluid Flywheel

Gear Box; Gear Shifting mechanism, synchromesh Gear box, Torque converter, Automatic Manual Transmission (AMT), Automatic Transmission (AT), Continuously Variable Transmission (CVT), Infinitely Variable Transmission (IVT)& IMT, Working of Differential.

Types Of Tyres- Radial & Conventional, Tubeless Tyres, Tubed Tyres- Puncture patching

Module-3 Direction Control & Braking

Steering system- mechanisms & Linkages, Steering gear boxes- Rack & pinion, worm & wheel construction & working, power Steering construction & working, steering geometry, Wheel balancing

Braking System- Mechanism and Linkages; Mechanical Brakes, Hydraulic Brakes, Power Brakes, Parking brakes, ABS

Suspension – layout & working of Hydraulic& Air suspension, independent suspension

Module-4 Exhaust Emission & Alternate Sources

Exhaust gas pollutants and their effects on environment, Emission norms, IC engine fuel types, extraction& availability,

BIOFUELS – Production and impact. Ethanol engines, CNG vehicles- operation, advantages

& disadvantages, overview of Hydrogen - fuel cell vehicles, advantages & disadvantages, IC engine/ electric hybrid vehicles overview, layout, transmission & control system, solar powered vehicles- wind powered vehicles, super capacitors, supply rails

Module-5 Electrical Vehicles

Electric vehicles principle and components- layout of two & 4-wheeler, Motors used in Electric vehicles –types- overview of construction and working, power transmission & control system in Electric vehicles. Batteries – construction & working principle of Lead acid, nickel based, sodium based, Lithium & Metal Air batteries. Battery charging types and requirements

Course outcome (Course Skill Set)

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

- Understand the working of different systems employed in automobile
- Analyse the limitation of present-day automobiles
- Evaluate the energy sources suitability
- Apply the knowledge for selection of automobiles based on their suitability

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assessment methods mentioned in the 22OB4.2, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment for a total of 50 marks.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

- Electric Vehicle Technology Explained James Larminie Oxford Brookes University, Oxford, UK John Lowry Acenti Designs Ltd., UK
- Automobile engineering, Kirpal Singh, Vol I and II (12th Edition) Standard Publishers 2011.
- Automotive Mechanics, S. Srinivasan, (2nd Edition) Tata McGraw Hill 2003.
- Automotive mechanics, William H Crouse & Donald L Anglin (10th Edition) Tata McGraw Hill Publishing Company Ltd., 2007.
- Modren Electric, Hybrid Electric, and Fuel Cell Vehicles,MehrdadEhsani, YiminGao, CRC Press, Taylor & Francis Group
- Automotive mechanics: Principles and Practices, Joseph Heitner, D Van Nostrand Company, Inc
- Fundamentals of Automobile Engineering, K.K.Ramalingam, Scitech Publications (India) Pvt. Ltd.
- Automobile Engineering, R. B. Gupta, SatyaPrakashan,(4th Edition) 1984.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/107/106/107106088/
- https://onlinecourses.nptel.ac.in/noc20_de06/preview
- https://www.digimat.in/nptel/courses/video/107106088/L01.html
- https://nptel.ac.in/courses/107106088
- https://www.youtube.com/watch?v=LZ82iANWBL0&list=PLbMVogVj5nJTW50jj9_gvJmdwFWHaqR5J

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Operate the cut section models of complete vehicle chassis and observe the working of all components
- Dismantle & Assemble the Automotive Engine, Gear Box, Clutch, brakes
- Prepare the posters of automobile chassis & display
- Visit nearby automobile showrooms/ service station
- Prepare a comparison statement of different automobiles using specification provided by respective manufacturers
- Visit auto expo

Basics of Matlab		Semester	6th
Course Code	**BME657A**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2*:0	SEE Marks	50
Total Hours of Pedagogy	12-14 sessions	Total Marks	100
Credits	01	Exam Hours	03
Examination nature (SEE)	**Practical**		

* Additional one hour may be considered for instructions, if required

Course objectives:

- To know about fundamentals of MATLAB tool.
- To provide an overview to program curve fitting & solve Linear and Nonlinear Equations.
- To understand the concept and importance of Fourier transforms.
- To gain knowledge about MATLAB Simulink & solve engineering problems.

Sl.NO	Experiments
1	Introduction to MATLAB Programming: Basics of MATLAB Programming, array operations in MATLAB, loops and execution of control, working with files: Scripts and functions, plotting and programming output, examples.
2	
3	Numerical Methods and their applications: Curve Fitting: Straight line fit, Polynomial fit.
4	
5	Numerical Integration and Differentiation: Trapezoidal method, Simpson method.
6	
7	Linear and Nonlinear Equations: Eigen values, Eigen vectors, Solution of linear algebraic equations using Gauss Elimination and LU decomposition, Solution of nonlinear equation in single variable using Gauss-Siedal and Newton-Raphson method.
8	
9	Ordinary Differential Equations: Introduction to ODE's, Euler's method, second order RungaKutta method, MATLAB ode45 algorithm in single variable and multivariable. Transforms: Discrete Fourier Transforms,
10	
11	Application of MATLAB to analyse problems in basic engineering mechanics, mechanical vibrations, control system, statistics and dynamics of different circuits.
12	MATLAB Simulink: Introduction to MATLAB Simulink, Simulink libraries, development of basic models in Simscape Power Systems

Course outcomes (Course Skill Set):

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

- Implement loops, branching, control instruction and functions in MATLAB programming environment.
- Programming for curve fitting, numerical differentiation and integration, solution of linear equations in MATLAB and solve engineering problems.
- Understand implementation of ODE using ode 45 and execute Solutions of nonlinear equations and DFT in MATLAB.
- Simulate MATLAB Simulink examples.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/

course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation (CIE):

CIE marks for the practical course are **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

Text Books:

1. Agam Kumar Tyagi, "**MATLAB and Simulink for Engineers**", OXFORD Higher Education.
2. Dr. Shailendra Jain, "**Modelling & Simulation using MATLAB – Simulink**", Wiley – India.

Reference Books:

1. Won Y.Tang, Wemun Cao, Tae-Sang Ching and John Morris, "**Applied Numerical Methods Using MATLAB**", A John Wiley & Sons.
2. Steven T. Karris, "**Introduction to Simulink with Engineering Applications**", Orchard Publications.

Fundamental of Virtual Reality ARP Development		Semester	VI
Course Code	**BME657B**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15 Hrs	Total Marks	100
Credits	01	Exam Hours	1
Examination type (SEE)	**Theory**		

Course objectives:

- Describe how VR systems work and list the applications of VR.
- Understand the design and implementation of the hardware that enables VR systems to be built.
- Understand the system of human vision and its implication on perception and rendering.
- Explain the concepts of motion and tracking in VR systems.
- Describe the importance of interaction and audio in VR systems.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1

Introduction to Virtual Reality: Defining Virtual Reality, History of VR, Human Physiology and Perception, Key Elements of Virtual Reality Experience, Virtual Reality System, Interface to the Virtual World-Input & output- Visual, Aural & Haptic Displays, Applications of Virtual Reality.

Module-2

Representing the Virtual World : Representation of the Virtual World, Visual Representation in VR, Aural Representation in VR and Haptic Representation in VR

Module-3

The Geometry of Virtual Worlds &The Physiology of Human Vision: Geometric Models, Changing Position and Orientation, Axis-Angle Representations of Rotation, Viewing Transformations, Chaining the Transformations, Human Eye, eye movements & implications for VR.

Module-4

Visual Perception & Rendering: Visual Perception - Perception of Depth, Perception of Motion, Perception of Color, Combining Sources of Information Visual Rendering -Ray Tracing and Shading Models, Rasterization, Correcting Optical Distortions, Improving Latency and Frame Rates.

Module-5

Motion & Tracking: Motion in Real and Virtual Worlds- Velocities and Accelerations, The Vestibular System, Physics in the Virtual World, Mismatched Motion and Vection Tracking- Tracking 2D & 3D Orientation, Tracking Position and Orientation, Tracking Attached Bodies

Course outcome (Course Skill Set)

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

CO1: Describe how VR systems work and list the applications of VR.

CO2: Understand the design and implementation of the hardware that enables VR systems to be built.

CO3: Understand the system of human vision and its implication on perception and rendering.

CO4: Explain the concepts of motion and tracking in VR systems.

CO5: Describe the importance of interaction and audio in VR systems.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous internal Examination (CIE)

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assessment methods mentioned in the 22OB4.2, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment for a total of 50 marks..

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 03 credit course, then

1. The question paper will have ten questions. Each question is set for 10 marks.
2. There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
3. The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Books

Text Books

1. Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016
2. Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig, (The Morgan Kaufmann Series in Computer Graphics)". Morgan Kaufmann Publishers, San Francisco, CA, 2002
3. Developing Virtual Reality Applications: Foundations of Effective Design, Alan B Craig, William R Sherman and Jeffrey D Will, Morgan Kaufmann, 2009.

Reference Books:

1. Gerard Jounghyun Kim, "Designing Virtual Systems: The Structured Approach", 2005.
2. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, "3D User Interfaces, Theory and Practice", Addison Wesley, USA, 2005.
3. Oliver Bimber and Ramesh Raskar, "Spatial Augmented Reality: Meging Real and Virtual Worlds", 2005.
4. Burdea, Grigore C and Philippe Coiffet, "Virtual Reality Technology", Wiley Interscience, India, 2003.

Web links and Video Lectures (e-Resources):

http://lavalle.pl/vr/book.html
https://nptel.ac.in/courses/106/106/106106138/
https://www.coursera.org/learn/introduction-virtual-reality.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Course Seminars

Simulation and Analysis using Ansys workbench		Semester	6th
Course Code	**BME657C**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	12 sessions	Total Marks	100
Credits	01	Exam hours	3
Examination nature (SEE)	Practical		

Course objectives:

1. General understanding of the user interface, as related to geometry import, meshing, application of loads and supports, and postprocessing
2. Procedure for performing FEA simulations, including linear static, modal, and harmonic structural analyses and nonlinear steady-state thermal analyses
3. Utilizing parameters for 'what-if' scenarios
4. To launch the individual software components and used to transfer data between them.
5. To see at-a-glance how a model has been built, and determine which files were used for a particular simulation (pairing geometry files to solver runs)
6. To perform parametric analyses (without the user needing to manually launch each application in turn) and makes it easy to simulate Multiphysics scenarios like fluid-structure interaction.

Sl.NO	Experiments
1	Bars of constant cross section area, tapered cross section area and stepped bar.
2	Trusses
3	Beams and (Simply supported, cantilever, beams with UDL, and beams with varying load etc.)
4	Frames
5	Stress analysis of a rectangular plate with a circular hole, axisymmetric problems.
6	Thermal Analysis -2D problem with conduction and convection boundary conditions
7	Fluid flow Analysis -Potential distribution in the 2 -D bodies
8	Magnetostatic: – Perform various magnetic field analyses.
	Demonstration Experiments (For CIE)
9	Electrical: – Simulate electrical devices such as motors, solenoids,
10	Fixed -fixed beam for natural frequency determination
11	Bar subjected to forcing function
12	Fixed -fixed beam subjected to forcing function

Course outcomes (Course Skill Set):

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

1. Covers fundamentals and practical knowledge of finite element modelling and simulation
2. Uses ANSYS Workbench as the FEA environment Describes simulation case studies demonstrated in a step-by-step fashion Includes a web-based geometry input CAD files for ANSYS Workbench examples Covers the analyses of trusses, beams, frames, plane stress and plane strain problems, plates and shells, three-dimensional design components, and assembly structures
3. APPLY basics of Theory of Elasticity to continuum problems.
4. FORMULATE finite elements like bar, truss and beam elements for linear static structural analysis. FORMULATE 2D and axisymmetric finite elements.
5. Develop finite element equations for 1D heat transfer elements and solve numericals.
6. Apply finite element simulation tool to solve practical problems (Lab and Self-study).

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation (CIE):

CIE marks for the practical course are **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and

scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

1. www.ansys.com
2. www.mece.ualberta.ca/tutorials/ansys
3. http://mae.uta.edu/~lawrence/
4. http://expertfea.com/tutorials.html

Introduction Augmented Reality		Semester	6th
Course Code	**BME657D**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	0:2:0:0	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	01	Exam Hours	01
Examination nature (SEE)	Theory		

Course objectives:

- Describe how AR systems work and list the applications of AR.
- Understand and analyse the hardware requirement of AR.
- Use computer vision concepts for AR and describe AR techniques
- Analyse and understand the working of various state of the art AR devices
- Acquire knowledge of mixed reality

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1

Introduction to Augmented Reality (A.R): Defining augmented reality, history of augmented reality, The Relationship between Augmented Reality and Other Technologies-Media, Technologies, Other Ideas Related to the Spectrum between Real and Virtual Worlds, applications of augmented reality

Augmented Reality Concepts: Concepts Related to Augmented Reality, Ingredients of an Augmented Reality Experience.

Module-2

Augmented Reality Hardware:

Augmented Reality Hardware – Displays – Audio Displays, Haptic Displays, Visual Displays, Other sensory displays, Visual Perception, Requirements and Characteristics, Spatial Display Model.

Processors – Role of Processors, Processor System Architecture, Processor Specifications.

Tracking & Sensors - Tracking, Calibration, and Registration, Characteristics of Tracking Technology, Stationary Tracking Systems, Mobile Sensors, Optical Tracking, Sensor Fusion.

Module-3

Computer Vision for Augmented Reality & A.R. Software: Computer Vision for Augmented Reality - Marker Tracking, Multiple-Camera Infrared Tracking, Natural Feature Tracking by Detection, Simultaneous Localization and Mapping, Outdoor Tracking

Augmented Reality Software - Introduction, Major Software Components for Augmented Reality Systems, Software used to Create Content for the Augmented Reality Application.

Module-4

AR Techniques- Marker based & Marker less tracking: Marker-based approach- Introduction to marker-based tracking, types of markers, marker camera pose and identification, visual tracking, mathematical representation of matrix multiplication

Marker types- Template markers, 2D barcode markers, imperceptible markers. Marker-less approach- Localization based augmentation, real world examples Tracking methods- Visual tracking, feature based tracking, hybrid tracking, and initialization and recovery.

Module-5

AR Devices & Components: AR Components – Scene Generator, Tracking system, monitoring system, display, Game scene

AR Devices – Optical See- through HMD, Virtual retinal systems, Monitor bases systems, Projection displays, and Video see-through systems

Course outcome (Course Skill Set)

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

CO1 : Describe how AR systems work and list the applications of AR.

CO2 : Understand and analyse the hardware requirement of AR.

CO3 : Apply computer vision concepts for AR and describe AR techniques

CO4 : Analyse and understand the working of various state of the art AR devices

CO5 : Explain the knowledge acquired on mixed reality

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assessment methods mentioned in the 22OB4.2, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment for a total of 50 marks.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. Allan Fowler-AR Game Development||, 1st Edition, A press Publications, 2018, ISBN 978-1484236178
2. Augmented Reality: Principles & Practice by Schmalstieg / Hollerer, Pearson Education India; First edition (12 October 2016),ISBN-10: 9332578494

Reference Books:

1. Designing for Mixed Reality, Kharis O'Connell Published by O'Reilly Media, Inc., 2016, ISBN: 9781491962381
2. Sanni Siltanen- Theory and applications of marker-based augmented reality. Julkaisija – Utgivare Publisher. 2012. ISBN 978-951-38-7449-0

Web links and Video Lectures (e-Resources):

- https://www.vttresearch.com/sites/default/files/pdf/science/2012/S3.pdf
- https://docs.microsoft.com/en-us/windows/mixed-reality/
- https://docs.microsoft.com/en-us/archive/msdn-magazine/2016/november/hololensintroduction-to-the-hololens

MOOC Courses:

- https://www.coursera.org/learn/ar
- https://www.udemy.com/share/101XPi/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Course seminar
- Term project

FINITE ELEMENT METHODS		Semester	7
Course Code	**BME701**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	3
Examination nature (SEE)	Theory		

Course objectives:

1. To learn basic principles of finite element analysis procedure.
2. To learn the theory and characteristics of finite elements that represent engineering structures.
3. To learn and apply finite element solutions to structural, thermal, dynamic problem to develop the knowledge and skills needed to effectively evaluate finite element analyses.

Teaching-Learning Process (General Instructions)

These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.

There are two components to the course: the theoretical part will expose the key concepts (weighted-residual method, natural vs. essential boundary conditions, basis functions, error measures, etc) and the technical details (element types, integration rules, equation assembly, post-processing, etc). The second component aims at providing hands-on experience with the method through its application to simple problems (bars, trusses & beams, dynamic and heat transfer, etc) of engineering interest and to problems that merit the use of a computational tool. Subject to the pace of the class, practical component is considered using software. The presentation of the material will be incremental starting from simple one-dimensional problems in order to illustrate and solidify the concepts and will progress to two- and three. The emphasis will be on the basic principles, in the methodology and in the physical interpretation of numerical results.

MODULE-1

Introduction to FEM:

Introduction to FEM, engineering applications, advantages, General steps, Element types, Convergence criteria, Coordinate systems, commercial packages-pre-processor, solver and post processor.

Principles of Elasticity: Strain- displacement relations, Stress-strain relations for 1D, 2D, and 3D cases, Plain stress and Plain strain conditions,

Introduction to Numerical Methods, Potential energy method, Rayleigh-Ritz method and Galerkin method-applied to simple problems on axially loaded members, cantilever, simply supported beams, with point loads and distributed loads.

MODULE-2

One Dimensional Element:

Formulation of a linear bar element, Shape Functions- Polynomial, The Potential Energy Approach, derivation of stiffness matrix, Properties of stiffness matrix, Assembly of Global Stiffness Matrix and Load Vector, Boundary conditions- elimination method and penalty method. Numerical Problems on straight and stepped bars. **(Problems with 2 elements only).**

MODULE-3

Trusses and Beams:

Formulation plane trusses element, Stiffness matrix (No derivation), Numerical Problems on point load, Formulation beam element, derivation of Hermite shape functions, stiffness matrix and load vector (No derivations), Numerical Problems on beams carrying concentrated, UDL and couples. **(Problems with 2 elements only).**

MODULE-4

Two dimensional Element:
Formulation of triangular and quadrilateral elements. Displacement models and shape functions for linear and higher order elements, Lagrangian and serendipity elements, Iso parametric – sub parametric – super parametric elements, Introduction to axisymmetric– triangular elements. Convergence criteria, pascal triangle. (No numerical problems)

MODULE-5

Dynamic considerations and Heat Transfer:
Dynamic considerations: Formulation for point mass and distributed masses, Consistent mass matrices for 1-D bar element, computation of eigen values and eigen vectors. Numerical Problems on straight and stepped bars.
Heat Transfer Problems: Steady state heat transfer, 1D heat conduction governing equation, boundary conditions, Numerical problems on composite wall, 1D heat transfer in thin fins.

PRACTICAL COMPONENT OF IPCC *(May cover all / major modules)*

Sl.NO	Experiments
1	Bars of constant cross section area, tapered cross section area and stepped bar with different materials
2	Trusses – (Minimum 3 exercises of different areas of cross sections of links, different supports such as fixed support, rolling support)
3	Beams – Simply supported, cantilever, beams with point load, UDL, beams with varying load etc. (Minimum 6 exercises)
4	Stress analysis of a rectangular plate with a circular hole
5	Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions (Heat transfer through composite section) Minimum of 2 exercises
6	Natural frequency of beam with fixed – fixed end condition
7	Response of beam with fixed – fixed end conditions subjected to forcing function
8	Demonstrate the use of graphics standards (IGES, STEP etc) to import the model from modeler to solver
9	**Can be Demo experiments for CIE** Demonstrate the use of graphics standards (IGES, STEP etc) to import the model from modeler to solver
10	**Can be Demo experiments for CIE** Demonstrate one example of contact analysis to learn the procedure to carry out contact analysis.
11	**Can be Demo experiments for CIE** Demonstrate at least two different type of example to model and analyze bars or plates made from composite material

Course outcomes (Course Skill Set):
At the end of the course, the student will be able to:

1. Understand the concepts behind formulation methods in FEM.
2. Identify the application and characteristics of FEM elements such as bars, beams, plane and iso-parametric elements.
3. Develop element characteristic equation and generation of global equation.
4. Apply suitable boundary conditions to a global equation for bars, trusses, beams, circular shafts, heat transfer, fluid flow, axi symmetric and dynamic problems.
5. Solving of displacements, stress and strains induced problems.

Assessment Details (both CIE and SEE)
The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the

SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**)

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored by the student shall be proportionally scaled down to 50 Marks

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper may include questions from the practical component.

Suggested Learning Resources:

Text Books:

1. Logan, D. L., A first course in the finite element method,6th Edition, Cengage Learning, 2016.
2. Rao, S. S., Finite element method in engineering, 5th Edition, Pergaman Int. Library of Science, 2010.
3. Chandrupatla T. R., Finite Elements in engineering, 2nd Edition, PHI, 2013.
4. O. C. Zienkiewicz and Y.K. Cheung, The Finite Element Method in Structural and Soild Mechanics, McGraw Hill, London

Reference Books:

1. J.N.Reddy, "Finite Element Method"- McGraw -Hill International Edition.Bathe K. J. Finite Elements Procedures, PHI.
2. Cook R. D., et al. "Conceptsand Application of Finite Elements Analysis"- 4th Edition, Wiley & Sons, 2003.
3. C.S.Krishnamoorty, Finite ElementAnalysis, Tata McGraw-Hill David V. Hutton, Fundamentals of Finite ElementAnalysis, McGraw Hill
4. D. Maity, Computer Analysis of Framed Structures, I.K. International Pvt. Ltd. New Delhi
5. Erik G. Thompson, Introduction to the Finite Element Method: Theory, Programming and Applications, John Wiley

Web links and Video Lectures (e-Resources):

http://icas.bf.rtu.lv/doc/Book.pdf
http://www.adina.com/MITRES2_002S10_linear.pdf
https://www.edx.org/course/finite-element-method-fem-analysis-tsinghuax-70120073x

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

https://www.edx.org/course/hands-introduction-engineering-cornellx-engr2000x
http://nptel.ac.in/courses/112104115/
https://www.coursetalk.com/providers/mit/courses/finite-element-analysis-of-solids-and-fluids-i
https://online-learning.tudelft.nl/courses/linear-modeling-fem/

Hydraulics & Pneumatics		Semester	7
Course Code	**BME702**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hrs + 8-10 lab sessions	Total Marks	100
Credits	04	Exam Hours	3
Examination nature (SEE)	**Theory**		

Course objectives:

- To provide an insight into the capabilities and applications of hydraulic and pneumatic fluid power.
- To understand concepts and relationships surrounding force, pressure, energy and power in fluid power systems.
- To examine concepts cantering on sources of hydraulic power, rotary and linear actuators, distribution systems, hydraulic flow in pipes, and control components in fluid power systems.
- Exposure to build and interpret hydraulic and pneumatic circuits related to industrial applications.
- To familiarize with logic controls and trouble shooting

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Intellectual skills; Concept of how to understand the procedures and codes for hydraulics and pneumatics
2. Cognitive strategy; Learner will use personal strategies to think and organise the course.
3. By creating learning activity to accomplish the course outcome.
4. By preparing ppt, showing animated videos and by giving some field-based activity.

Module-1

Introduction to fluid power systems

Fluid power system: components, advantages and applications. Transmission of power at static and dynamic states. Pascal's law and its applications.

Fluids for hydraulic system: types, properties, and selection. Additives, effect of temperature and pressure on hydraulic fluid. Seals, sealing materials, compatibility of seal with fluids. Fluid conditioning through filters, strainers; sources of contamination and contamination control; heat exchangers.

Module-2

Pumps and Actuators

Pumps: Classification of pumps, pumping theory of positive displacement pumps, construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps, Pump performance characteristics, pump selection factors, problems on pumps.

Actuators: Classification cylinder and hydraulic motors, Hydraulic cylinders, single and double acting cylinder, mounting arrangements, cushioning, special types of cylinders, problems on cylinders. Construction and working of rotary actuators such as gear, vane, piston motors, and Hydraulic Motor. Theoretical torque, power, flow rate, and hydraulic motor performance; numerical problems. Symbolic representation of hydraulic actuators (cylinders and motors).

Accumulators: Types, selection/ applications of accumulators

Module-3

Components and Hydraulic Circuit Design

Components: Classification of control valves, Directional Control Valves-symbolic representation, constructional features of poppet, sliding spool, shuttle valve, and check valves.

Pressure control valves - types, direct operated types and pilot operated types.

Flow Control Valves -compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation.

Hydraulic Circuit Design: Control of single and Double -acting hydraulic cylinder, regenerative circuit, pump unloading circuit, double pump hydraulic system, counterbalance valve application, hydraulic cylinder sequencing circuits, cylinder synchronizing circuit using different methods, hydraulic circuit for force multiplication; speed control of hydraulic cylinder metering in, metering out. Hydraulic circuit examples with accumulator.

Module-4

Pneumatic Power Systems

Introduction to Pneumatic systems: Pneumatic power system, advantages, limitations, applications, Choice of working medium. Characteristics of compressed air and air compressors. Structure of pneumatic control System, fluid conditioners-dryers and FRL unit.

Pneumatic Actuators: Linear cylinder – types of cylinders, working, end position cushioning, seals, mounting arrangements, and applications. Rotary cylinders- types, construction and application, symbols.

Pneumatic Control Valves: DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve, Quick exhaust valve, time delay valve.

Module-5

Pneumatic Control Circuits

Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, speed control of cylinders - supply air throttling and exhaust air throttling.

Signal Processing Elements: Use of Logic gates - OR and AND gates in pneumatic applications. Practical examples involving the use of logic gates.

Multi- Cylinder Application: Coordinated and sequential motion control, motion and control diagrams. Signal elimination methods, Cascading method- principle, Practical application examples (up to two cylinders) using cascading method (using reversing valves).

PRACTICAL COMPONENT OF IPCC *(May cover all / major modules)*

Sl.NO	Experiments
1	A] Study of Construction and working Hydraulic pumps and Pneumatic B] Study of Hydraulic and Pneumatic valves. C] Study of solenoid valves, limit switches. Pressure, flow control valve
2	Basic hydraulic circuit for the working of double acting cylinder and a hydraulic motor
3	Basic pneumatic circuit for the working of single and double acting cylinder.
4	Speed control circuits. Different Metering methods Inlet & outlet flow control (meter-in & meter-out circuit)
5	Circuits for the Use of different direction control valves and valve actuation in single And double acting cylinder, and multi actuation circuit.
6	Hydraulic Counter-balancing circuit.

7	Hydraulic or Pneumatic Regenerative circuit.
8	Hydraulic or Pneumatic Sequencing circuit.
9	**Can be Demo experiments for CIE** Circuit with cam operated pilot valves operating a pilot operated 4way direction control Valve or proximity/ limit switches, solenoid operated 4way direction control valve for Auto reversing circuit.
10	**Can be Demo experiments for CIE** Study of hydraulics and Pneumatics circuit, based on the industrial application. (At least one in each)

Course outcome (Course Skill Set)

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

CO1: Identify and analyse the functional requirements of a fluid power transmission system for a given application.

CO2: Understand the operation, application, and maintenance of common fluid power components such as pumps, actuators and accumulators.

CO3: Design an appropriate hydraulic or pneumatic circuit or combination circuit like electro-hydraulics, electro- pneumatics for a given application.

CO4: Explain the pneumatic working media, applications and components of pneumatic system.

CO5: Develop a comprehensive circuit diagram by integrating the components selected for the given application using signal processing element.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be

conducted for 50 marks and scaled down to **10 marks.**

- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**)

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored by the student shall be proportionally scaled down to 50 Marks
5. **The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper may include questions from the practical component**.

Suggested Learning Resources:

List of Text Books:

1. Anthony Esposito, "Fluid Power with applications", Pearson edition, 2000.
2. Majumdar S.R., "Oil Hydraulics", Tala McGRaw HllL, 2002.
3. Majumdar S.R., "Pneumatic systems - Principles and Maintenance", Tata McGraw-Hill, New Delhi, 2005

Reference Books:

1. John Pippenger, Tyler Hicks, "Industrial Hydraulics", McGraw Hill International Edition, 1980.
2. Andrew Par, Hydraulics and pneumatics, Jaico Publishing House, 2005.
3. FESTO, Fundamentals of Pneumatics, Vol I, II and III.
4. Herbert E. Merritt, "Hydraulic Control Systems", John Wiley and Sons, Inc.
5. Thomson, Introduction to Fluid power, Prentcie Hall, 2004.
6. John Watton, "Fundamentals of fluid power control", Cambridge University press, 2012.

Web links and Video Lectures (e-Resources):

. **List of URLs, Text Books, Notes, Multimedia Content, etc**

1. https://nptel.ac.in/courses/112105047/
2. https://www.youtube.com/watch?v=8xd7cWyMrvE
3. https://nptel.ac.in/courses/105103096/
4. https://nptel.ac.in/courses/112105047/37

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

1. Basic laws of hydraulics and Power in hydraulic system used in fluid power system.
2. Prepare working models of hydraulic crane using waste injections used by doctors. (Laboratory based)
3. Prepare report of agriculture equipment's working on hydraulics and pneumatics (Field based)
4. Collect technical specifications of pumps and motors and actuators. (Internet based)
5. Prepare visit report to observe use of pneumatic system used in automobile, Medical and agriculture (Field based)
6. Constructions and working of different types of circuits for various applications using hydraulic and pneumatic kit (portable).
7. Collections of animation videos of pumps, motors, actuators and Filters.(Software based)
8. Market survey of hydraulic oils used in hydraulic system. (Field based)

CONTROL ENGINEERING		Semester	7th
Course Code	**BME703**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	(3:0:0:0)	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	**Theory**		

Course objectives:

- Study the fundamental concepts of Control systems and their mathematical modelling.
- Study the concept of time and frequency response of the system.
- Study the stability analysis of the control system.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt teaching methods using PowerPoint presentation, Video demonstration.
2. Use of appropriate software tools to demonstrate the frequency response of the systems.
3. Adopt collaborative (Group Learning) learning in the class.
4. Adopt problem-based learning which fosters student's analytical skills and develop thinking skills.

Module-1

Introduction: Concept of automatic controls, Open loop and closed loop systems, Concepts of feedback, requirements of an ideal control system.

Types of controllers: Proportional, Integral Proportional Integral, Proportional Integral Differential controllers.

Mathematical Models: Transfer function models, models of mechanical systems, models of electrical circuits, models of thermal systems and models of hydraulic systems.

Module-2

Block Diagrams and Signal Flow Graphs: Transfer Functions definition, block representation of systems elements, reduction of block diagrams, Signal flow graphs: Mason's gain formula.

System Compensation: Series and feedback compensation, Lead compensator, Lag Compensator.

Module-3

Transient and Steady State Response Analysis: Introduction, test inputs, first order and second order system response to step, ramp and impulse inputs, concepts of time constant and its importance in speed of response. Steady state error, error constants.

Module-4

System stability: Routh's stability Criterion

Root Locus Plots: Definition of root loci, General rules for constructing root loci, Analysis using root locus plots.

Module-5

Frequency Response Analysis: Polar plots, Nyquist stability criterion, Bode Plots, Determination of phase margin and gain margin using Bode plot.

Course outcome (Course Skill Set)

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

1. Explain the control system and its types, control actions and develop system governing equations for physical models (Mechanical, Electrical, Thermal &Hydraulic Systems)
2. Analysis on the response of control system for standard test signals.
3. Apply block diagram & signal flow representations to obtain transfer function of control systems.
4. Analyse the stability of transfer functions in complex domain and frequency domain.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assessment methods mentioned in the 22OB4.2, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment for a total of 50 marks.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Modern Control Engineering, Katsuhiko Ogatta, Pearson Education, Fifth edition.
2. Modern Control Systems, Richard.C.Dorf and Robert.H.Bishop, Addison Wesley, Thirteenth Edition.
3. Control Systems Principles and Design, M.Gopal, Fourth Edition, TMH.
4. Automatic Control Systems, Benjamin C. Kuo, Farid Golnaraghi, McGraw Hill Education, Tenth Edition

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc22_ee31/preview
- https://plc-coep.vlabs.ac.in/exp/pid-controller/index.html

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Frequency response of control system using MATLAB/SCILAB or any open-source software tools.

Additive manufacturing		Semester	7
Course Code	**BME714A**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3-0-0-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	**Theory**		

Course objectives:

- To know the principal methods, areas of usage, possibilities and limitations of the Additive Manufacturing technologies.
- To be familiar with the characteristics of the different materials those are used in Additive Manufacturing.
- To know the principles of polymerization and powder metallurgy process, extrusion-based system printing processes, sheet lamination processes, beam deposition processes, direct write technologies Direct Digital Manufacturing.
- To get exposed to process selection, software issues and post processing.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Adopt flipped classroom teaching method.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1

Introduction and basic principles: Need for Additive Manufacturing, Generic AM process, stereo lithography or 3dprinting, rapid prototyping, the benefits of AM, distinction between AM and CNC machining, other related technologies- reverse engineering technology.

Development of Additive Manufacturing Technology: Introduction, computers, computer-aided design technology, other associated technologies, the use of layers, classification of AM processes, metals systems, hybrid systems, milestones in AM development.

Additive Manufacturing Process chain: Introduction, the eight steps in additive manufacture, variations from one AM machine to another, metal systems, maintenance of equipment, materials handling issues, design for AM, and application areas.

Module-2

Photo polymerization processes: Stereo lithography (SL), Materials, SL resin curing process, Micro- Stereo lithography, Process Benefits and Drawbacks, Applications of Photo polymerization Processes.

Powder bed fusion processes: Introduction, Selective laser Sintering (SLS), Materials, Powder fusion mechanism, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Process Benefits and Drawbacks, Applications of Powder Bed Fusion Processes.

Extrusion-based systems: Fused Deposition Modelling (FDM), Principles, Materials, Plotting and path control, Bio-Extrusion, Process Benefits and Drawbacks, Applications of Extrusion-Based Processes.

Module-3

Printing Processes: evolution of printing as an additive manufacturing process, research achievements in printing deposition, technical challenges of printing, printing process modelling, material modification methods, three-dimensional printing, advantages of binder printing

Sheet Lamination Processes: Materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications.

Beam Deposition Processes: introduction, general beam deposition process, description material delivery, BD systems, process parameters, typical materials and microstructure, processing–structure–properties relationships, BD benefits and drawbacks.

Direct Write Technologies: Background, ink –based DW, laser transfer, DW thermals pray, DW beam deposition, DW liquid-phase direct deposition.

Module-4

Guidelines for Process Selection: Introduction, selection methods for apart, challenges of selection, example system for preliminary selection, production planning and control.

Software issues for Additive Manufacturing: Introduction, preparation of cad models – the STL file, problems with STL files, STL file manipulation.

Post- Processing: Support material removal, surface texture improvements, preparation for use as a pattern, property enhancements using non-thermal techniques and thermal techniques.

Module-5

The use of multiple materials in additive manufacturing: Introduction, multiple material approaches, discrete multiple material processes, porous multiple material processes, blended multiple material processes, commercial applications using multiple materials, future directions.

AM Applications: Examples for Aerospace, defence, automobile, Bio-medical and general engineering industries. Direct digital manufacturing: Align Technology, Siemens and Phonak, DDM drivers, manufacturing vs. prototyping, lifecycle costing, future of direct digital manufacturing.

Course outcome (Course Skill Set)

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

1. Demonstrate the knowledge of the broad range of AM processes, devices, capabilities and materials that are available.
2. Demonstrate the knowledge of the broad range of AM processes, devices, capabilities and materials that are available.
3. Describe the various software tools, processes and techniques that enable advanced/additive manufacturing.
4. Apply the concepts of additive manufacturing to design and create components that satisfy product development/prototyping requirements, using advanced/additive manufacturing devices and processes.
5. Elucidate characterization techniques in additive manufacturing.
6. Illustrate the latest trends and business opportunities in additive manufacturing.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assessment methods mentioned in the 22OB4.2, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment for a total of 50 marks

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing I. Gibson l D. W. Rosen l B. Stucker Springer New York Heidelberg Dordrecht, London ISBN: 978-1- 4419-1119-3 e-ISBN: 978- 1-4419- 1120-9 DOI 10.1007/978 -1-4419- 1120-9
2. "Rapid Prototyping: Principles & Applications Chua Chee Kai, Leong Kah Fai World Scientific 2003
3. Rapid Prototyping: Theory & Practice Ali K. Kamrani, Springer 2006 Emand Abouel Nasr,
4. Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling" D.T. Pham, S.S. Dimov Springer 2001
5. Rapid Prototyping: Principles and Applications in Manufacturing Rafiq Nooran John Wiley & Sons 2006
6. Additive Manufacturing Technology Hari Prasad, A.V. Suresh Cengage 2019
7. Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing Andreas Gebhardt

Web links and Video Lectures (e-Resources):

- .

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Case studies
- Quiz
- Topic Seminar presentation
- Assignments

Product Design and Management		Semester	7th
Course Code	**BME714B**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3-0-0-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	Theory		

Course objectives:

- Understanding the user-centred design process including form and colour theory.
- Understanding product metamorphosis, and ergonomics..
- Implement the principles of ergonomics and how to apply the principles to industrial design.
- Understand the importance and techniques of human biological data collection and experiments.
- Obtain a knowledge and ability towards Accident Investigation and Safety Management.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Adopt flipped classroom teaching method.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1

Introduction to Product Design: Asimows Model: Definition of product design, Design by Evaluation, Design by Innovation, Essential Factors of Product Design, Flow and Value Addition in the Production-Consumption Cycle. The Morphology of Design (The seven Phase), Primary Design phase and flowcharting, role of Allowance, Process Capability.

Module-2

Ergonomics and Industrial Design: Introduction -general approach to the man- machine relationship- workstation design-working position.

Ergonomics and Production: Ergonomics and product design –ergonomics in automated systems- expert systems for ergonomic design. Anthropometric data and its applications in ergonomic, design- limitations of anthropometric data use of computerized database. Case study.

Module-3

Aesthetic Concepts: Concept of unity- concept of order with variety - concept of purpose style and environment- Aesthetic expressions. Style components of style- house style, observation style in capital goods, case study.

Module-4

Visual Effects of Line and Form: The mechanics of seeing- psychology of seeing general influences of line and form.

Colour: Colour and light -colour and objects- colour and the eye -colour consistency- colour terms- reactions to colour and colour continuation -colour on engineering equipment's.

Module-5

Ergonomics of Technology Management: Office Systems and Ergonomics, Consumer Ergonomics, Ergonomics Quality and Safety, Quality of Life

Course outcome (Course Skill Set)

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

1. Illustrate the concept of product design and the ergonomics.
2. Design the various controls and displays by knowing the anthropometric data.
3. Charaterize the psychology of visuals effects.
4. Evaluate the different colour combinations for optimal design of engineering equipments.
5. Understand the importance of environmental factors and aesthetics in industrial design and management.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assessment methods mentioned in the 22OB4.2, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment for a total of 50 marks

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Human Factors in Engineering and Design By Sanders & Mccormick (McGrawHill Publication)
2. Occupational Ergonomics – Principles and Applications By Tayyari & Smith (Chapman & Hall Publication)
3. The Power of Ergonomics as a Competitive Strategy By Gross & Right (Productivity Press)
4. Industrial Design for Engineers - Mayall W.H. - London Hiffee books Ltd. -1988.

5. Applied Ergonomics Hand Book - Brain Shakel (Edited) - Butterworth scientific. London - 1988. 6. Introduction to Ergonomics - R. C. Bridger - McGraw Hill Publications - 1995.
6. Human Factor Engineering - Sanders & McCormick – McGraw Hill Publications – 6th edition, 2002.
7. Ulrich, Karl T, Eppinger, Steven D, 'Product Design and Development', McGraw-Hill, 2004.
8. Bridger RS, 'Introduction to Human Factors & Ergonomics', Fourth Edition, Taylor & Francis, 2010.
9. Dul. J and Weerdmeester B, 'Ergonomics for beginners, a quick reference guide, Taylor & Francis, 2008

Web links and Video Lectures (e-Resources):

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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Anthropometry
- Hand strength and Back strength
- Measurement of Environmental Factors
- Grip Strength – Hand and Pinch

IC ENGINES		Semester	7th
Course Code	**BME714C**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

- To give an overview of Internal Combustion Engines, their classification, applications, operation and processes.
- To describe combustion phenomena in IC engines
- To give complete knowledge of type of fuels used in IC engines and the fuel supply systems.
- To explain the different performance analysis of IC engines
- To explain the effects of exhaust emission on human health and various pollution norms

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Arrange visits to show the live working models other than laboratory topics.
- Adopt collaborative (Group Learning) Learning in the class.
- Adopt Problem Based Learning (PBL), which foster students' Analytical skills and develops
- Thinking skills such as evaluating, generalizing, and analyzing information.

Module-1

I.C. Engines - Classification based on multi cylinder engine, firing order, selection criteria of IC engines based on application, materials and manufacturing processes of ICE components.

Thermodynamic cycle analysis– Deviation from ideal processes. Effect of chemical equilibrium and variable specific heats. Effect of air fuel ratio and exhaust gas dilution. Calculation of combustion temperatures. Use of combustion charts. Simple. numerical problems.

Module-2

Carburetion and combustion process in S.I. engines: Mixture requirements in S.I engine. Simple Carburettor and its limitations. Knock fee and knocking combustion-Theories of combustion process in S.I. engines. Effect of Knock on engine performance. Effect of operating variables on knocking. Knock rating of fuels-octane number. HUCR values. Anti knock agents - Pre-ignition - Post ignition.

Combustion in C.I. engines: Ricardo's three stages of combustion process in C.I. engines. Delay period & factors affecting delay period. Diesel knock- Methods of controlling diesel knock. Knock rating of Diesel fuels.

Module-3

Combustion chambers: Requirements of combustion chambers. Features of different types of combustion chambers system for S.I. engine. I-head, F-head combustion chambers. C.I. engine combustion chambers-Air swirl turbulence-M. type combustion chamber. Comparison of various types of combustion chambers.

Fuels: Hydro carbons - chemical structure-influence of chemical structure on knock alternative fuels-Alcohols-vegetable oils- Bio gas as Diesel engine fuels.

Module-4

Fuel injection systems: Diesel injection systems-jerk pump injectors Nozzles of different types-Petrol injection systems for S.I. engines-Electronic fuel injection system. Cooling system- Water cooling, air cooling & liquid cooling-role of thermostats-radiator construction.

Module-5

Modern developments: Turbo charging and super charging of I.C.Engines, Stratified charge engines (Lean burned SI engine) Multi fuel engines, Rotary piston engine, Two injector engines Pilot ignition engine, all ceramic swirl chamber engines.

Emission regulation and Control systems: Mechanism of pollutant formation. Total emission control package thermal reactor package-catalytic converter package-control of NOX -Exhaust gas recirculation-Water injection.

Course outcome (Course Skill Set)

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

CO1: Understand various types of I.C. Engines, Cycles of operation and Identify fuel metering, fuel supply systems for different types of engines.

CO2: Explain the operating characteristics and thermodynamic analysis of common internal combustion engine cycles.

CO3: Understand combustion phenomena in SI and CI engines and Analyze the effect of various operating variables on engine performance.

CO4: To analyze the combustion process of common fuels.

CO5: Understand the conventional and non-conventional fuels and effects of emission formation of IC engines, its effects and the legislation standards.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assessment methods mentioned in the 22OB4.2, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment for a total of 50 marks.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Test Books

1. Heywood J.B., "Internal combustion Engine Fundamentals", McGraw Hill, 1988
2. Domkundwar V.M., "Internal combustion Engines", 6th Ed.Tata McGraw Hill Publishing Co.
3. PulkrabekW , "Internal combustion engines", 8th Ed.; Dhanpat Rai publication.,2003,

REFERENCE BOOKS

1. Ganesan V , "Internal combustion Engine and Air Pollution", Intext Educational Pub,1974.
2. Ferguson and Kirkpatric; Internal Combustion Engines, by Wiley publishers.

Web links and Video Lectures (e-Resources):

- https://youtu.be/vIJ50aUiBgM
- https://youtu.be/fTAUq6G9apg
- https://youtu.be/_Ko0jJsQWxA
- https://youtu.be/GR0oI5sDCww
- https://youtu.be/sz8cqygvPC4
- https://youtu.be/GWav5n1x6hQ

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

1. Demonstration of IC engine.
2. Overhauling of IC engine (assembling and disassembling of 4-cylinder diesel jeep engine).
3. Emission test of IC engine vehicles.
4. Video demonstration of latest trends in IC engine.
5. Visit to nearest automotive sales and service shop.

Cryogenics		Semester	7th
Course Code	**BME714D**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3-0-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory/practical/Viva-Voce /Term-work/Others		

Course Objectives:

1. To understand cryogenic system and gas liquefaction system
2. To analyze gas cycle cryogenic refrigeration system
3. To Comprehend gas separation and gas purification system
4. To have detailed knowledge of vacuum technology, insulation, storage of cryogenic liquids
5. To study applications of cryogenics and to embark on cryogenic fluid

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations.
- Chalk and Talk method for Problem Solving.
- Adopt collaborative (Group Learning) learning in the class.

Module-1

Introduction to Cryogenic Systems: Cryogenic propellants and its applications, liquid hydrogen, liquid nitrogen, and liquid Helium The thermodynamically Ideal system Production of low temperatures – Joule Thompson Effect, Adiabatic expansion. Gas Liquefaction Systems: Liquefaction systems for Air Simple Linde –Hampson System, Claude System, Heylndt System, Dual pressure, Claude. Liquefaction cycle Kapitza System. Comparison of Liquefaction Cycles Liquefaction cycle for hydrogen, helium and Neon, Critical components of liquefaction systems.

Module-2

Gas Cycle Cryogenic Refrigeration Systems: Classification of Cryo coolers, Stirling cycle Cryo – refrigerators, Ideal cycle – working principle. Schmidt‘s analysis of Stirling cycle, Various configurations of Stirling cycle refrigerators, Integral piston Stirlingcryo-cooler, Free displacer split type StirlingCryo coolers, Gifford Mcmahon Cryo- refrigerator, Pulse tube refrigerator, Solvay cycle refrigerator, Vuillimier refrigerator, Cryogenic regenerators.

Module-3

Gas Separation and Gas Purification Systems Thermodynamic ideal separation system, Properties of mixtures, Principles of gas separation, Linde single column air separation. Linde double column air separation, Argon and Neon separation systems. Ultra Low Temperature Cryo – Refrigerators Magneto Caloric Refrigerator 3He-4He Dilution refrigerator. Pomeranchuk cooling. Measurement systems for low temperatures, Temperature measurement at low temperatures, Resistance thermometers, Thermocouples, Thermistors, Gas Thermometry. Liquid level sensors.

Module-4

Vacuum Technology Vacuum Technology: Fundamental principles. Production of high vacuum, Mechanical vacuum pumps, Diffusion pumps, Cryo-pumping, Measurement of high vacuum level. Cryogenic Insulation: Heat transfer due to conduction, Evacuated porous insulation Powder & Fibers Opacified powder insulation, Gas filled powders & Fibrous materials Multilayer super-insulation, Composite insulation

Module-5

Cryogenic Fluid Storage and Transfer Systems Design of cryogenic fluid storage vessels, Inner vessel, Outer Insulation, Suspension system, Fill and drain lines. Cryogenic fluid transfer, External pressurization, Self-pressurization, Transfer pump. Application of Cryogenic Systems Cryogenic application for food preservation – Instant Quick Freezing Techniques Super conductive devices, Cryogenic applications for space technology. Application of cryogenic systems, super conducting devices, space technology, cryogenic in biology and medicine.

Course outcome (Course Skill Set)

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

1. Understand the cryogenic system.
2. Demonstrate the complete knowledge of cryogenic refrigeration system
3. Design gas separation and gas purification systems
4. Solve the problem in , insulation, storage of cryogenic liquids
5. Apply cryogenic in various areas and to be able take up research in cryogenics

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assessment methods mentioned in the 22OB4.2, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment for a total of 50 marks.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Text Books

1. Cryogenic Systems – R.F. Barron
2. Cryogenic Engineering – R.B. Scott – D.VanNostrand Company, 1959

REFERENCE BOOKS:

1. Cryogenic Process Engineering – K.D. Timmerhaus and T.M. Flynn, Plenum Press, New York,1989
2. High Vacuum Technology – A. Guthree – New Age International Publication
3. Experimental Techniques in Low Temperature Physics – G.K. White – Oxford University Press,

Web links and Video Lectures (e-Resources):

- VTU-E-learning.
- NPTEL

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Quiz
- Topic Seminar presentation
- Assignments

Introduction to NON-TRADITIONAL MACHINING		Semester	VII
Course Code	**BME755A**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hrs	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

To learn various concepts related to modern machining processes & their applications.

- To appreciate the differences between conventional and non-conventional machining processes.
- To acquire a functional understanding of non-traditional manufacturing equipment.
- To know about various process parameters and their influence on performance and their applications.
- To impart knowledge on various types of energy involved in non-traditional machining processes.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Arrange visits to show the live working models other than laboratory topics.
- Adopt collaborative (Group Learning) Learning in the class.
- Adopt Problem Based Learning (PBL), which foster students' Analytical skills and develops Thinking skills such as evaluating, generalizing, and analyzing information.

Module-1

Introduction to Non-traditional machining, Need for Non-traditional machining process, Comparison between traditional and non-traditional machining, general classification Non-traditional machining processes, classification based on nature of energy employed in machining, selection of non-traditional machining processes, Specific advantages, limitations and applications of non-traditional machining processes.

Module-2

Ultrasonic Machining (USM): Introduction, Equipment and material process, Effect of process parameters: Effect of amplitude and frequency, Effect of abrasive grain diameter, effect of slurry, tool & work material. Process characteristics: Material removal rate, tool wear, accuracy, surface finish, applications, advantages & limitations of USM.

Abrasive Jet Machining (AJM):

Introduction, Equipment and process of material removal, process variables: carrier gas, type of abrasive, work material, stand-off distance (SOD). Process characteristics-Material removal rate, Nozzle wear, accuracy & surface finish. Applications, advantages & limitations of AJM.

Module-3

ELECTROCHEMICAL MACHINING (ECM): Introduction, Principle of electro chemical machining, ECM equipment, elements of ECM operation, Chemistry of ECM. ECM Process characteristics: Material removal rate, accuracy, surface finish. Process parameters: Current density, Tool feed rate, Gap between tool & work piece, velocity of electrolyte flow, type of electrolyte, its concentration temperature, and choice of electrolytes. ECM Tooling: ECM tooling technique & example, Tool & insulation materials. Applications ECM: Electrochemical grinding and electrochemical honing process. Advantages, disadvantages and application of ECG, ECH.

CHEMICAL MACHINING (CHM): Elements of the process, Resists (maskants), Etchants. Types of chemical machining process-chemical blanking process, chemical milling process. Process

characteristics of CHM: material removal rate, accuracy, surface finish, advantages, limitations and applications of chemical machining process.

Module-4

ELECTRICAL DISCHARGE MACHINING (EDM): Introduction, mechanism of metal removal, EDM equipment: spark erosion generator (relaxation type), dielectric medium-its functions & desirable properties, electrode feed control system. Flushing types; pressure flushing, suction flushing, side flushing, pulsed flushing.

EDM process parameters: Spark frequency, current & spark gap, surface finish, Heat Affected Zone. Advantages, limitations & applications of EDM, Electrical discharge grinding, Traveling wire EDM. PLASMA ARC MACHINING (PAM): Introduction, non-thermal generation of plasma, equipment mechanism of metal removal, Plasma torch, process parameters, process characteristics. Safety precautions. Safety precautions, applications, advantages and limitations

Module-5

LASER BEAM MACHINING (LBM): Introduction, generation of LASER, Equipment and mechanism of metal removal, LBM parameters and characteristics, Applications, Advantages & limitations.

ELECTRON BEAM MACHINING (EBM): Introduction, Principle, equipment and mechanism of metal removal, applications, advantages and limitations.

Course outcome (Course Skill Set)

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

CO1: Understand the compare traditional and non-traditional machining process and recognize the need for Non- traditional machining process.

CO2: Explain the constructional features, performance parameters, process characteristics, applications, advantages and limitations of USM, AJM and WJM.

CO3: Identify the need of Chemical and electro-chemical machining process along with the constructional features, process parameters, process characteristics, applications, advantages and limitations.

CO4: Understand the constructional feature of the equipment, process parameters, process characteristics, applications, advantages and limitations EDM & PAM.

CO5: Understand the LBM equipment, LBM parameters, and characteristics. EBM equipment and mechanism of metal removal, applications, advantages and limitations LBM & EBM.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assessment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment for a total of 50 marks.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Text Books:

1. Modern Machining Process by P.C Pandey and H S Shah, McGraw Hill Education India Pvt. Ltd. 2000
2. Production technology, HMT, McGraw Hill Education India Pvt. Ltd 2001

Reference Books:

1. New Technology, Dr. Amitabha Bhattacharyya, The Institute of Engineers (India) 2000
2. Modern Machining process, Aditya, 2002

Web links and Video Lectures (e-Resources):

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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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Basics of Hydraulics & Pneumatics		Semester	7
Course Code	**BME755B**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination nature (SEE)	Theory		

Course objectives:

- To provide an insight into the capabilities and applications of hydraulic and pneumatic fluid power.
- To understand concepts and relationships surrounding force, pressure, energy and power in fluid power systems.
- To examine concepts cantering on sources of hydraulic power, rotary and linear actuators, distribution systems, hydraulic flow in pipes, and control components in fluid power systems.
- Exposure to build and interpret hydraulic and pneumatic circuits related to industrial applications.
- To familiarize with logic controls and trouble shooting

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Intellectual skills; Concept of how to understand the procedures and codes for hydraulics and pneumatics
2. Cognitive strategy: Learner will use personal strategies to think and organise the course.
3. By creating learning activity to accomplish the course outcome.
4. By preparing ppt, showing animated videos and by giving some field-based activity.

Module-1

Introduction to fluid power systems

Fluid power system: components, advantages and applications. Transmission of power at static and dynamic states. Pascal's law and its applications.

Fluids for hydraulic system: types, properties, and selection. Additives, effect of temperature and pressure on hydraulic fluid. Seals, sealing materials, compatibility of seal with fluids. Fluid conditioning through filters, strainers; sources of contamination and contamination control

Module-2

Pumps and actuators

Pumps: Classification of pumps, pumping theory of positive displacement pumps, construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps, Pump performance characteristics, pump selection factors,

Actuators: Classification cylinder and hydraulic motors, Hydraulic cylinders, single and double acting cylinder, cushioning, special types of cylinders, Construction and working of rotary actuators such as gear, vane, piston motors, and Hydraulic Motor. Symbolic representation of hydraulic actuators (cylinders and motors).

Accumulators: Types, selection/ applications of accumulators

Module-3

Components and hydraulic circuit design

Components: Classification of control valves, Directional Control Valves-symbolic representation, constructional features of poppet, sliding spool, shuttle valve, and check valves.

Pressure control valves - types, direct operated types and pilot operated types.

Flow Control Valves -compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation.

Hydraulic Circuit Design: Control of single and Double -acting hydraulic cylinder, regenerative circuit,

pump unloading circuit, double pump hydraulic system, counterbalance valve application, hydraulic cylinder sequencing circuits, cylinder synchronizing circuit using different methods, speed control of hydraulic cylinder metering in, metering out. Hydraulic circuit examples with accumulator.

Module-4

Module4: Pneumatic power systems

Introduction to Pneumatic systems: Pneumatic power system, advantages, limitations, applications, Choice of working medium. Characteristics of compressed air and air compressors. Structure of pneumatic control System, fluid conditioners-dryers and FRL unit.

Pneumatic Actuators: Linear cylinder – types of cylinders, working, end position cushioning, seals, mounting arrangements, and applications.

Pneumatic Control Valves: DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve, Quick exhaust valve, time delay valve.

Module-5

Module5: Pneumatic control circuits

Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, speed control of cylinders - supply air throttling and exhaust air throttling.

Signal Processing Elements: Use of Logic gates – OR, AND, NOT and NAND gates in pneumatic applications. Practical examples involving the use of logic gates.

Multi- Cylinder Application: Coordinated and sequential motion control, motion and control diagrams. Signal elimination methods, Cascading method- principle, Practical application examples (up to two cylinders).

Course outcome (Course Skill Set)

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

CO1: Identify and analyse the functional requirements of a fluid power transmission system for a given application.

CO2: Understand the operation, application, and maintenance of common fluid power components such as pumps, actuators and accumulators.

CO3: Design an appropriate hydraulic or pneumatic circuit or combination circuit like electro-hydraulics, electro- pneumatics for a given application.

CO4: understand the pneumatic working media, applications and components of pneumatic system.

CO5: Develop a comprehensive circuit diagram by integrating the components selected for the given application using signal processing element.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB4.2, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

List of Text Books:

1. Anthony Esposito, "Fluid Power with applications", Pearson edition, 2000.
2. Majumdar S.R., "Oil Hydraulics", Tala McGRaw HllL, 2002.
3. Majumdar S.R., "Pneumatic systems - Principles and Maintenance", Tata McGraw-Hill, New Delhi, 2005

Reference Books:

1. John Pippenger, Tyler Hicks, "Industrial Hydraulics", McGraw Hill International Edition, 1980.
2. Andrew Par, Hydraulics and pneumatics, Jaico Publishing House, 2005.
3. FESTO, Fundamentals of Pneumatics, Vol I, II and III.
4. Herbert E. Merritt, "Hydraulic Control Systems", John Wiley and Sons, Inc.
5. Thomson, Introduction to Fluid power, Prentcie Hall, 2004
6. John Watton, "Fundamentals of fluid power control", Cambridge University press, 2012.

Web links and Video Lectures (e-Resources):

. **List of URLs, Text Books, Notes, Multimedia Content, etc**

1. https://nptel.ac.in/courses/112105047/
2. https://www.youtube.com/watch?v=8xd7cWvMrvE
3. https://nptel.ac.in/courses/105103096/
4. https://nptel.ac.in/courses/112105047/37

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

OPERATIONS RESEARCH		Semester	7th
Course Code	**BME755C**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

- To introduce students to use quantitative methods and techniques for effective decisions–making;
- Mathematical model formulation and solving business decision problems.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Use of Chalk and Talk method
2. Video lectures, lecture projections in class
3. Individual and Group assignments

Module-1

Introduction: Evolution of OR, definition of OR, scope of OR, application areas of OR, steps (phases) in OR study, characteristics and limitations of OR, models used in OR, linear programming (LP) problem-formulation and solution by graphical method. The simplex method using slack variables.

Module-2

Transportation Problem: Formulation of transportation problem, types, initial basic feasible solution using different methods, optimal solution by MODI method, degeneracy in transportation problems, application of transportation problem concept for maximization cases. **Assignment Problem:** Formulation, types, application to maximization cases and travelling salesman problem.

Module-3

PERT-CPM Techniques: Introduction, network construction - rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project; crashing of simple projects.

Module-4

Game Theory: Formulation of games, types, solution of games with saddle point, graphical method of solving mixed strategy games, dominance rule for solving mixed strategy games.

Queuing Theory: Queuing systems and their characteristics, Pure-birth and Pure-death models (only equations), empirical queuing models (M/M/1 model).

Module-5

Sequencing: Basic assumptions, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines. Sequencing 2 jobs on 'm' machines using graphical method.

Course outcome (Course Skill Set)

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

- Understand the importance, phases, & limitations of operations research.
- Formulate a real-world problem in OR as a mathematical model.
- Apply PERT and CPM network techniques to solve project management problems.
- Choose appropriate OR models to solve transportation problem, assignment model, game theory, queuing theory and sequencing models.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assessment methods mentioned in the 22OB4.2, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment for a total of 50 marks.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. **Operations Research,** P K Gupta and D S Hira, 7th Edition, Chand Publications, New Delhi
2. **Operations Research,** R. Panneerselvam, 3rd Edition, PHI
3. **Operations Research Theory, Methods & Applications,** S.D. Sharma, Kedarnath Ramanath & Co, 2012.
4. **Operations Research**, A M Natarajan, P Balasubramani, Pearson Education, 2005
5. **Introduction to Operations Research**, Hillier and Lieberman, 8th Edn, McGraw Hill,

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/112106134

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Use appropriate software tools to solve real world problems Operations Research for different businesses

NON-CONVENTIONAL ENERY RESOURCES		Semester	7th
Course Code	**BME755D**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	03	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

- To introduce the concepts of solar energy, its radiation, collection, storage and application.
- To introduce the concepts and applications of Wind energy, Biomass energy, Geothermal energy and Ocean energy as alternative energy sources.
- To explore society's present needs and future energy demands.
- To examine energy sources and systems, including fossil fuels and nuclear energy, and then focus on alternate, renewable energy sources such as solar, biomass (conversions), wind power, geothermal, etc.
- To get exposed to energy conservation methods.

Module-1

Introduction:

Energy source, India's production and reserves of commercial energy sources, need for non-conventional energy sources, energy alternatives, solar, thermal, photovoltaic. Waterpower, wind biomass, ocean temperature difference, tidal and waves, geothermal, tar sands and oil shale, nuclear (Brief descriptions); advantages and disadvantages, comparison (Qualitative and Quantitative).

Solar Radiation Measurement of Solar Radiation

Solar Radiation: Extra-Terrestrial radiation, spectral distribution of extra-terrestrial radiation, solar constant, solar radiation at the earth's surface, beam, diffuse and global radiation, solar radiation data. Measurement of Solar Radiation: Pyrometer, shading ring pyrheliometer, sunshine recorder, schematic diagrams and principle of working.

Module-2

Solar Radiation Geometry: Flux on a plane surface, latitude, declination angle, surface azimuth angle, hour angle, zenith angle, solar altitude angle expression for the angle between the incident beam and the normal to a plane surface (No derivation) local apparent time. Apparent motion of sum, day length, numerical examples.

Radiation Flux on a Tilted Surface Solar Thermal Conversion

Radiation Flux on a Tilted Surface: Beam, diffuse and reflected radiation, expression for flux on a tilted surface (no derivations) numerical example. Solar Thermal Conversion: Collection and storage, thermal collection devices, liquid flat plate collectors, solar air heaters concentrating collectors (cylindrical, parabolic, paraboloid) (Quantitative analysis); sensible heat storage, latent heat storage, application of solar energy water heating. Space heating and cooling, active and passive systems, power generation, refrigeration. Distillation (Qualitative analysis) solar pond, principle of working, operational problems**.**

Module-3

Performance Analysis of Liquid Flat Plate Collectors

General description, collector geometry, selective surface (qualitative discussion) basic energy-balance equation, stagnation temperature, transmissivity of the cover system, transmissivity – absorptivity product, numerical examples. The overall loss coefficient, correlation for the top loss coefficient, bottom and side loss coefficient, problems (all correlations to be provided). Temperature distribution between the collector tubes, collector heat removal factor, collector efficiency factor and collector flow factor, mean plate temperature, instantaneous efficiency (all expressions to be provided). Effect of various parameters on the collector performance; collector orientation, selective surface, fluid inlet temperature, number covers, dust.

Photovoltaic Conversion

Photovoltaic Conversion: Description, principle of working and characteristics, applications.

Module-4

Wind Energy:

Properties of wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, wind machines; Types of wind machines and their characteristics, horizontal and vertical axis windmills, elementary design principles; coefficient of performance of a windmill rotor, aerodynamic considerations of windmill design, numerical examples.

Tidal Power:

Tides and waves as energy suppliers and their mechanics; fundamental characteristics of tidal power, harnessing tidal energy, limitations.

Ocean Thermal Energy Conversion:

Principle of working, Rankine cycle, OTEC power stations in the world, problems associated with OTEC.

Module-5

Hydrogen Energy:

Properties of Hydrogen with respected to its utilization as a renewable form of energy, sources of hydrogen, production of hydrogen, electrolysis of water, thermal decomposition of water, thermo chemical production bio-chemical production. Storage & Transportation Methods: Gaseous, cryogenic and metal hydrides, application of hydrogen, domestic and industrial safe burning of hydrogen.

Geothermal Energy Conversion:

Principle of working, types of geothermal station with schematic diagram, geothermal plants in the world, problems associated with geothermal conversion, scope of geothermal energy.

Energy from Biomass:

Photosynthesis, photosynthetic oxygen production, energy plantation, biogas production from organic wastes by anaerobic fermentation, description of bio-gas plants, transportation of biogas, problems involved with bio-gas production, application of bio-gas, application of bio-gas in engines, advantages.

Course outcome (Course Skill Set)

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

1. Describe the environmental aspects of non-conventional energy resources in Comparison with various conventional energy systems, their prospects and limitations, the need of renewable energy resources, historical and latest developments.
2. Describe the use of solar energy and the various components used in the energy production with respect to applications like-heating, cooling, desalination, power generation, drying, cooking etc.
3. Explain the need of Wind Energy and the various components used in energy generation and know the classifications.
4. Understand the concept of Biomass energy resources and their classification, types of biogas Plants- applications.
5. Compare the working principles of fuel cells, wave power, tidal power and geothermal principles and applications.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

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3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Non-Convention Energy Resources by B H Khan, 3rd Edition ,McGraw Hill Education (India) Pvt. Ltd.
2. Non-Conventional Energy Sources by G.D Rai, Khanna Publishers (2003).
3. Solar Energy by Subhas P Sukhatme, 2nd Edition Tata Mcgraw Hill (1996).
4. Renewable energy sources and Conversion technology by N.K.Bansal, Manfred Kleeman and Mechael Meliss, Tata Mcgraw Hill (2004).

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=ybZbwKIB1Ic
- https://onlinecourses.nptel.ac.in/noc23_ge04/preview.
- https://www.youtube.com/watch?v=LOVZE9WalRE Fundamentals of Photovoltaics
- https://www.youtube.com/watch?v=BcVzc6IGwS0 This lecture explores factors that affect the amount of sunlight reaching Earth's surface: e.g. orbit and tilt, scattering in the atmosphere, weather, and diffuse vs. direct sunlight.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Visit to Nearby power Plants, Solar Plants , Wind Mills etc
- Case studies and Quiz.
- Topic Seminar presentation.