Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur

Faculty of Science & Technology

Scheme of Examination and Evaluation

Bachelor of Technology (Mechanical Engineering) (Choice Based Credit System)

III Semester B. Tech (Mechanical Engineering)

Sr No	Course Code	Category	Course Title	Teaching Scheme (Hours/Week)			Credits	Examination Scheme								
								Theory					Practical			
				L	T	P		Duration of Exam (Hrs)	Max. Marks College Assesment	Max. Marks University Assessment	Total Marks	Min. Passing Marks	Max. Marks College Assesment	Max. Marks University Assessment	Total Marks	Min. Passing Marks
1	BEME301T	Basic Science course	Applied Mathematics – III	3	-	-	3	3	30	70	100	45	-	-	-	-
2	BEME302T	Professional core courses	Manufacturing Processes	3	-	-	3	3	30	70	100	45	-	-	-	-
3	BEME302P	Professional core courses	Manufacturing Processes Lab	-	-	2	1	-	-	-	-	-	25	25	50	25
4	BEME303T	Professional core courses	Fluid Mechanics	3	-	-	3	3	30	70	100	45	-	-	-	-
5	BEME304T	Professional core courses	Kinematics of Machines	3	-	-	3	3	30	70	100	45	-	-	-	-
6	BEME305P	Professional core courses	Machine Drawing & Solid Modelling	-	1	2	2	-	-	-	-	-	50	50	100	50
7	BEME306T	Professional core courses	Material Science & Engineering	3	-	-	3	3	30	70	100	45	-	-	-	-
8	BEME307P	Project work, seminar and internship in industry or elsewhere	Skill Development (Basics of Computer aided drafting)		-	2	1	-	-	-	-	-	50	-	50	25
9	BEME308P	Mandatory Course	Sports / Yoga / NSS/NCC	-	-	2	Audit (0)	College Assessment in Grades O, A, B, C (Evaluation is to be done out of 50 marks, Evaluation guidelines mentioned in the syllabus of concerned course)								
Total				**15**	**1**	**8**	**-**	-	**150**	**350**	**500**	-	**125**	**75**	**200**	-
Semester Total				**24**			**19**	**Marks 700**								

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur
Faculty of Science & Technology
Scheme of Examination and Evaluation
Bachelor of Technology (Mechanical Engineering) (Choice Based Credit System)
IV Semester B. Tech (Mechanical Engineering)

Sr No	Course Code	Category	Course Title	Teaching Scheme (Hours/Week)			Credits	Examination Scheme								
								Theory					Practical			
				L	T	P		Duration of Exam (Hrs)	Max. Marks College Assesment	Max. Marks University Assessment	Total Marks	Min. Passing Marks	Max. Marks College Assesment	Max. Marks University Assessment	Total Marks	Min. Passing Marks
1	BEME401T	Professional core courses	Machining Processes	3	-	-	3	3	30	70	100	45	-	-	-	-
2	BEME401P	Professional core courses	Machining Processes Lab	-	-	2	1	-	-	-	-	-	25	25	50	25
3	BEME402T	Professional core courses	Hydraulic Machines	3	-	-	3	3	30	70	100	45	-	-	-	-
4	BEME402P	Professional core courses	Fluid Mechanics & Hydraulic Machines Lab	-	-	2	1	-	-	-	-	-	25	25	50	25
5	BEME403T	Professional core courses	Mechanics of Materials	3	-	-	3	3	30	70	100	45	-	-	-	-
6	BEME403P	Professional core courses	Material Testing Lab	-	-	2	1	-	-	-	-	-	25	25	50	25
7	BEME404T	Professional core courses	Engineering Thermodynamics	3	-	-	3	3	30	70	100	45	-	-	-	-
8	BEME405P	Professional core courses	Computer Programming	-	1	2	2	-	-	-	-	-	25	25	50	25
9	BEME406T	Humanities & Social Science	Professional Ethics	3	-	-	3	3	30	70	100	45	-	-	-	-
10	BEME407P	Project work, seminar and internship in industry or elsewhere	Skill Development (Training on Matlab)	-	-	2	1	-	-	-	-	-	50	-	50	25
TOTAL				**15**	**1**	**10**	**-**	**-**	**150**	**350**	**500**	**-**	**150**	**100**	**250**	**-**
Semester Total				**26**			**21**	**Marks 750**								

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur
Faculty of Science & Technology
Scheme of Examination and Evaluation
Bachelor of Technology (Mechanical Engineering) (Choice Based Credit System)
V Semester B. Tech (Mechanical Engineering)

Sr No	Course Code	Category	Course Title	Teaching Scheme (Hours/Week)			Credits	Examination Scheme								
								Theory					Practical			
				L	T	P		Duration of Exam (Hrs)	Max. Marks College Assesment	Max. Marks University Assessment	Total Marks	Min. Passing Marks	Max. Marks College Assesment	Max. Marks University Assessment	Total Marks	Min. Passing Marks
1	BEME501T	Professional core courses	Heat Transfer	3	-	-	3	3	30	70	100	45	-	-	-	-
2	BEME501P	Professional core courses	Heat Transfer Lab	-	-	2	1	-	-	-	-	-	25	25	50	25
3	BEME502T	Professional core courses	Energy Conversion-I	3	-	-	3	3	30	70	100	45	-	-	-	-
4	BEME503T	Professional core courses	Design of Machine Elements	3	1	-	4	3	30	70	100	45	-	-	-	-
5	BEME504T	Humanities, Social Sciences & Management courses	Industrial Econmics and Management	3	-	-	3	3	30	70	100	45	-	-	-	-
6	BEME505T	Professional core courses	Mechanical Measurement & Metrology	3	-	-	3	3	30	70	100	45	-	-	-	-
7	BEME505P	Professional core courses	Mechanical Measurement & Metrology Lab	-	-	2	1		-	-	-	-	25	25	50	25
8	BEME506P	Project work, seminar and internship in industry or elsewhere	Industrial Visit*	-	-	2	1	-	-	-	-	-	50	-	50	25
9	BEME507P	Mandatory Course	Performing Art	-	-	2	Audit (0)	College Assessment in Grades O, A, B, C (Evaluation is to be done out of 50 marks, Evaluation guidelines mentioned in the syllabus of concerned course)								
TOTAL				**15**	**1**	**8**	-	-	**150**	**350**	**500**	-	**100**	**50**	**150**	-
Semester Total				**24**			**19**	**Marks 650**								

Industrial Visit*	**Visit to minimum TWO industries must be carried out by every student. Visit to be carried out in a batch of 6 students. Assessment should be based on Visit report and presentation.**

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur
Faculty of Science & Technology
Scheme of Examination and Evaluation
Bachelor of Technology (Mechanical Engineering) (Choice Based Credit System)
VI Semester B. Tech (Mechanical Engineering)

Sr No	Course Code	Category	Course Title	Teaching Scheme (Hours/Week)			Credits	Examination Scheme								
								Theory					Practical			
				L	T	P		Duration of Exam (Hrs)	Max. Marks College Assessment	Max. Marks University Assessment	Total Marks	Min. Passing Marks	Max. Marks College Assessment	Max. Marks University Assessment	Total Marks	Min. Passing Marks
1	BEME601T	Professional core courses	Automation in Production	3	-	-	3	3	30	70	100	45	-	-	-	-
2	BEME601P	Professional core courses	Automation in Production Lab	-	-	2	1	-	-	-	-	-	25	25	50	25
3	BEME602T	Professional core courses	Energy Conversion-II	3	-	-	3	3	30	70	100	45	-	-	-	-
4	BEME602P	Professional core courses	Energy Conversion Lab	-	-	2	1		-	-	-	-	25	25	50	25
5	BEME603T	Professional core courses	Dynamics of Machines	3	-	-	3	3	30	70	100	45	-	-	-	-
6	BEME603P	Professional core courses	Dynamics of Machines Lab	-	-	2	1	-	-	-	-	-	25	25	50	25
7	BEME604T	Professional Elective courses	Elective - I	3	-	-	3	3	30	70	100	45	-	-	-	-
8	BEME605T	Professional Elective courses	Elective - II	3	-	-	3	3	30	70	100	45	-	-	-	-
9	BEME606T	Open Elective Course	Open Elective - I	3	-	-	3	-	30	70	100	45	-	-	-	-
11	BEME607T	Mandatory Course	Environment Science	2	-	-	Audit (0)	College Assessment in Grades O, A, B, C (Evaluation is to be done out of 50 marks. Evaluation guidelines mentioned in the syllabus of concerned course)								
TOTAL				**18**	**0**	**8**	-	-	**180**	**420**	**600**		**75**	**75**	**150**	-
Semester Total				**26**			**21**	**Marks 750**								
Summer Internship**			**Summer Internship should be undertaken after end of 6th Semester for a minimum duration of 4 weeks in Industry/ Research Institute/ Organizations & its evaluation to be done in 7th semester**													

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur

Faculty of Science & Technology

Scheme of Examination and Evaluation

Bachelor of Technology (Mechanical Engineering) (Choice Based Credit System)

VII Semester B. Tech (Mechanical Engineering)

Sr No	Course Code	Category	Course Title	Teaching Scheme (Hours/Week)			Credits	Examination Scheme								
								Theory					Practical			
				L	T	P		Duration of Exam (Hrs)	Max. Marks College Assessment	Max. Marks University Assessment	Total Marks	Min. Passing Marks	Max. Marks College Assessment	Max. Marks University Assessment	Total Marks	Min. Passing Marks
1	BEME701T	Professional Elective courses	Elective - III	3	-	-	3	3	30	70	100	45	-	-	-	-
2	BEME701P	Professional Elective courses	Elective - III Lab	-	-	2	1	-	-	-	-	-	25	25	50	25
3	BEME702T	Professional core courses	Energy Conversion III	3	-	-	3	3	30	70	100	45	-	-	-	-
5	BEME703T	Open Elective Course	Open Elective - II	3	-	-	3	3	30	70	100	45	-	-	-	-
6	BEME704T	Professional core courses	Design of Transmission systems	3	1	-	4	3	30	70	100	45				
7	BEME705P	Project work, seminar and internship in industry or elsewhere	Summer Internship**	During Summer Vacation after sixth semester			2	-	-	-	-	-	50	-	50	25
8	BEME706P	Project work, seminar and internship in industry or elsewhere	Project Phase I	-	-	6	3	-	-	-	-	-	50	-	50	25
9	BEME707P	Project work, seminar and internship in industry or elsewhere	Employability Enhancement*	-	-	2	1	-	-	-	-	-	50	-	50	25
TOTAL				**12**	**1**	**10**	-	-	**120**	**280**	**400**	-	**175**	**25**	**200**	-
Semester Total				**23**			**20**	**Marks 600**								

Summer Internship**	**Summer Internship should be undertaken after end of 6th Semester for a minimum duration of 4 weeks in Industry/ Research Institute/ Organizations & its evaluation to be done in 7th semester**
Employability Enhancement*	**Students should be given training on Technical aptitude, General aptitude, Group Discussion, Interview Techniques to enhance their chances of employment**

Note: A load of 2 hours/week per project guide for the course "Project Phase I"

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur
Faculty of Science & Technology
Scheme of Examination and Evaluation
Bachelor of Technology (Mechanical Engineering) (Choice Based Credit System)
VIII Semester B. Tech (Mechanical Engineering)

Sr No	Course Code	Category	Course Title	Teaching Scheme (Hours/Week)			Credits	Examination Scheme								
								Theory					Practical			
				L	T	P		Duration of Exam (Hrs)	Max. Marks College Assessment	Max. Marks University Assessment	Total Marks	Min. Passing Marks	Max. Marks College Assessment	Max. Marks University Assessment	Total Marks	Min. Passing Marks
1	BEME801T	Professional core courses	Industrial Engineering	3	-	-	3	3	30	70	100	45	-	-	-	-
2	BEME802T	Professional Elective courses	Elective - IV	3	-	-	3	3	30	70	100	45	-	-	-	-
3	BEME802P	Professional Elective courses	Elective - IV Lab	-	-	2	1	-	-	-	-	-	25	25	50	25
4	BEME803T	Professional Elective courses	Elective - V	3	-	-	3	3	30	70	100	45	-	-	-	-
5	BEME804T	Professional Elective courses	Elective - VI	3	-	-	3	3	30	70	100	45	-	-	-	-
6	BEME805P	Project work, seminar and internship in industry or elsewhere	Project Phase II	-	-	12	6	-	-	-	-	-	100	100	200	100
TOTAL				**12**	**0**	**14**	-	-	**120**	**280**	**400**	-	**125**	**125**	**250**	-
Semester Total				**26**			**19**	**Marks 650**								

Note: A load of 4 hours/week per project guide for the course "Project Phase II"

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur

Faculty of Science & Technology

Scheme of Examination and Evaluation

Bachelor of Technology (Mechanical Engineering) (Choice Based Credit System)

ELECTIVE I	ELECTIVE II	ELECTIVE III	ELECTIVE IV	ELECTIVE V	ELECTIVE VI	OPEN ELECTIVE I	OPEN ELECTIVE II
VI SEM	**VI SEM**	**VII SEM (T+P)**	**VIII SEM (T+P)**	**VIII SEM**	**VIII SEM**	**VI SEM**	**VII SEM**
Operation Research	Advanced Manufacturing Techniques	Mechatronics	Finite Element Method	Heating Ventilation & Air Conditioning	Industrial IOT	Entrepreneurship Development	Introduction to Electric Vehicles
Production Planning & Control	Power Plant Engineering	Computer Aided Design	Computer Integrated Manufacturing	Electric and Hybrid Vehicles	Additive Manufacturing	Automobile Engineering	Waste Management
Tool Design	Supply Chain Management	Advancements in Automobile Engineering	Refrigeration & Air conditioning	Design of Material Handling systems	Energy Conservation and Management	Project Evaluation & Management	Finance & Cost Management
Renewable Energy sources	Introduction to Artificial Intelligence	Computational Fluid Dynamics	CNC & Robotics	Total Quality Management	Green & Sustainable Manufacturing	Operation Research Techniques	Industrial Robotics
						Industrial Safety & Environment	Introduction to Renewable Energy resources

Note : Open electives are strictly applicable for other branches students only.

RTM Nagpur University - Mechanical Engineering
B. Tech 3rd Semester
Applied Mathematics – III (BTME301T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
III	Applied Mathematics – III	3	-	-	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	A primary objective is to introduce and develop advanced mathematical skills of students that are imperative for effective understanding of engineering subjects.
2	The topics covered will equip them with the techniques to understand advanced level Mathematics and its applications that would enrich logical thinking power.
3	Understand the impact of scientific and engineering solutions in a global and societal context.
4	Create the groundwork for post-graduate courses, specialized study, and research in mathematics.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Apply Laplace Transform to solve ordinary differential equations, Integral equations and Integro-differential Equations.
CO2	Apply Fourier series in the analysis of periodic functions in terms sine and cosine encountered in engineering problems and Fourier Transform to solve integral equations.
CO3	Learn the concept of differentiating, integrating and expanding of analytic functions in complex numbers and their applications such as evaluation of integrals of complex functions
CO4	Solve partial differential equations of first order, higher order with constant coefficients and of second order using method of separation of variables.
CO5	Analyze real world scenarios to recognize when matrices are appropriate, formulate problems about the scenarios, creatively model these scenarios in order to solve the problems using multiple approaches.

SYLLABUS	
Contents	**No of hours**
Unit I **LAPLACE TRANSFORM** Definition, Properties (Statement only), Evaluation of integrals by Laplace transform, Inverse Laplace transform using partial fraction method and properties of Laplace transform, Convolution theorem (Statement only), Laplace transform of periodic functions (Statement only), Unit step function and unit impulse function (Statement only), Applications of Laplace transform to solve ordinary differential equations, Integral equations & Integro-differential equations.	08
Unit II **FOURIER SERIES & FOURIER TRANSFORM** **Fourier Series:** Periodic functions and their Fourier expansions, Even and odd functions, Change of interval, Half range expansions. **Fourier Transform:** Definition and Properties (excluding FFT), Fourier integral theorem, Applications of Fourier transform to solve integral equations.	08
Unit III **FUNCTIONS OF COMPLEX VARIABLES** Analytic function, Cauchy-Riemann conditions, Harmonic function (Excluding orthogonal system), Milne-Thomson method, Cauchy integral theorem & integral formula (Statement only), Taylor"s & Laurent"s series (Statement only), Zeros and singularities of analytic function, Residue theorem (Statement only).	08
Unit IV **PARTIAL DIFFERENTIAL EQUATIONS** Partial differential equations of first order first degree i.e. Lagrange"s form, Linear homogeneous equations of higher order with constant coefficients, Method of separationsof variables, Simple applications of Laplace transform to solve partial differential equations (One dimensional only).	08
Unit V **MATRICES** Linear dependence of vectors, Eigen values and Eigen vectors, Reduction to diagonal form, Singular value decomposition, Sylvester's theorem (Statement only), Largest eigen value and corresponding eigen vector by iteration method.	08

Text/Reference Books:

(1) Advanced Engineering Mathematics (Wiley), Erwin Kreyzig.
(2) Higher Engineering Mathematics (Khanna Publishers), B. S. Grewal.
(3) Advanced Engineering Mathematics (S. Chand), H. K. Dass.
(4) Applied Mathematics for Engineers and Physicists, L. A. Pipes and L. R. Harville.
(5) Advanced Mathematics for Engineers, Chandrika Prasad.
(6) A text book of Engineering Mathematics (Laxmi Publication), N. P. Bali & M. Goyal.

RTM Nagpur University- Mechanical Engineering
B. Tech 3rd Semester
Manufacturing Processes (BTME302T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
III	Manufacturing Processes	3	-	-	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	To understand the pattern making, gating system, moldings process and casting process.
2	To expose the students to the principles of the metal joining methods.
3	To study metal forming techniques, rolling, drawing, sheet metal forming, shearing operations and knowledge about process behavior.
4	To learn about plastics, ceramics and glass along with properties, types, applications and shaping

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Understand the importance of manufacturing processes, techniques of pattern making and molding with their properties. Design gating system along with selection ofdifferent types of melting furnaces and special casting process.
CO2	Get acquainted with the basic concept of joining process, welding process and its types, defects and application.
CO3	Get acquainted with the forming process for metal, mechanics of forming process along with different types of rolling machine.
CO4	Understand and define press working process along with its classification, types and terminology, different types of dies and introduction to shaping operation.
CO5	Understand introduction to plastics, ceramics and glasses, its properties, application, forming and its shaping.

SYLLABUS	
Contents	**No of hours**
Unit I **Pattern Making & Moulding:** - Pattern making: Types, materials used, Pattern making allowances, color codes. **Moulding sand:** Composition, molding sand properties, Sand testing - Grain fineness, moisture content, clay content and permeability test. **Core making:** - Types, core material & its properties. **Gating System & Casting Processes:** - Elements of gating systems, riser. **Melting furnaces** - Types, Cupola, **Casting defects** - Types, Causes & remedies **Types of casting:** Investment Casting, Centrifugal Casting, Slush Casting, Die Casting, Shell moulding and CO_2 moulding.	08
Unit II **Joining Processes:** - Welding, brazing and Soldering Broad classification of welding processes, types and Principles. Electrodes, weldability of Metals, Welding equipments. Fixtures, Arc Welding & Gas Welding Processes, TIG Welding, MIG Welding, Spot Welding, Plasma Arc welding and Electron Laser Beam welding. Inspection, Defects in various joints and their remedies.	08
Unit III **Forming Process for metals:**- Rolling, Forging, Extrusion, Drawing, Types & classification, Applications, Principles of all processes	08
Unit IV **Sheet metal working**: - Classification, types of presses, press terminology, Force analysis in press working (PROBLEMS NOT EXPECTED) , Die cutting operation, types of dies, Die and punch allowance, introduction to shaping operations, bending, forming and drawing.	08
Unit V Introduction to Plastics, Properties & types, applications, Forming & Shaping of plastics –Extrusion, injection moulding, Blow moulding, wire drawing, Compression moulding, Transfer moulding, Embossing, Calendaring. Ceramic Structure, Properties, and Applications, Shaping Ceramics, Glasses Structure, Properties, and Applications, Forming and shaping of glass, Composite materials, Processing of metal matrix and ceramic matrix composites (overview)	08

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students as assignments.

References:

Text Books Recommended:

1. Workshop Practice, H. S. Bawa, Tata Mc-Graw Hill
2. Manufacturing Engineering & Technology, Kalpakjian, Pearson
3. Modern Materials and Manufacturing Process, R. Gregg Bruce, John E. Neely,Pearson Education
4. Degarmon's Materials and Processes in Manufacturing, 11th Ed. Black, Ronald A Kohser, Wiley India
5. Workshop Technology (Volume I), Hajra Chaudhary, Media Promoters &Publishers
6. Workshop Technology (Vol. I & II), B. S. Raghuwanshi, Dhanpat Rai & Co.
7. Manufacturing technology (Vol. I), P. N. Rao, Tata Mc-Graw Hill
8. Manufacturing Science, Ghosh & Malik, East West Press.
9. Textbook of Production Engineering, P.C. Sharma, S. Chand & Co.
10. "ASM Metals Hand Book on Casting", 1992.
11. Parmer R.S; "Welding Processes& Technology", Khanna Publishers, 1994.
12. Lancaster J.F., George Allen and Unwin, 1991, "Metallurgy of Welding".
13. Metals Hand Book, Vol 6, 8th edition, ASM, 1971.
14. AWS Welding Hand Book,Vol 1 to 4 AWS.

Reference Books Recommended:

1. Workshop Technology, Vol I & II, WAJ Chapman, Elsevier Butterworth-Heinemann.
2. Manufacturing Processes, M. Begman.
3. Processes & Materials of Manufacturing, R. Lindberg, Allyn & Bacon.

RTM Nagpur University Mechanical Engineering
B. Tech 3rd Semester
Manufacturing Processes Lab (BTME302P)
Syllabus (Practical)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
III	Manufacturing Processes Lab	-	-	2	1	25	25	50

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Think in core concept of their engineering application by studying various topics involved in branchspecific applications.
CO2	Understand the relevance and importance of the Different manufacturing techniques and real lifeapplication in industry.
CO3	Design the gating and riser system needed for casting and requirements to achieve defect free casting.
CO4	Analyze the welding process behavior and requirements to achieve sound welded joint while weldingdifferent similar and dissimilar engineering material
CO5	Understand the plastic, glass and ceramic Processing

Sr. No.	List of Practical's
01	Study of Cupola Furnace.
02	Study of Moulding Techniques
03	Study of Casting Process
04	Study of Pattern Making
05	Study of Joining Processes
06	Study of Forming Processes
07	Study of Drawing Processes
08	One Job – Pattern Making
09	One Job – Casting
10	One Job – on TIG/ MIG/ Resistance welding
11	Demonstration on Plastic, Glass and Ceramic Processing (Industrial Visit)

Suggested References:

1. Workshop Technology, Vol I & II, WAJ Chapman, Elsevier Butterworth-Heinemann.
2. Manufacturing Processes, M. Bagman.
3. Processes & Materials of Manufacturing R. Lindberg, Allyn & Bacon

RTM Nagpur University - Mechanical Engineering
B. Tech 3rd Semester
FLUID MECHANICS (BTME303T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
III	Fluid Mechanics	3	-	-	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	Understand fluid properties and differentiate various fluid flow types.
2	Analyze fluid statics principles and determine pressure distribution on surfaces and buoyancy of bodies.
3	Explore fluid dynamics equations and their applications in fluid flow scenarios.
4	Differentiate laminar and turbulent flows and apply dimensional analysis techniques in fluid mechanics.
5	Calculate energy losses in pipes and analyze lift and drag forces on immersed bodies.

Course Outcomes

After successful completion of this course the student will be able to:

CO1	Analyze fluid behaviors based on properties and identify fluid flow types in practical applications.
CO2	Apply fluid statics principles to assess pressure distributions, determine buoyancy, andanalyze stability.
CO3	Demonstrate proficiency in solving fluid dynamics problems using the Navier-Stokesequation, Bernoulli's equation, and related principles in various engineering scenarios.
CO4	Differentiate laminar and turbulent flows, apply dimensional analysis techniques,and interpret dimensionless parameters.
CO5	Calculate energy losses in pipes, understand fluid behavior in series and parallelconfigurations, and analyze lift and drag forces.

SYLLABUS

Contents	No of hours
Unit I **Fluid Properties:** - Types of fluids, Mass Density, Specific Weight, Specific Gravity, Newton's Law of Viscosity, Dynamic Viscosity, Stroke's Theorem, Surface Tension, Capillarity, Compressibility, Vapour pressure. **Fluid Kinematics:** - Types of Flow- steady, unsteady, uniform, non-uniform, laminar, turbulent, one, two and three dimensional, compressible, incompressible, rotational, irrotational.	08
Unit II **Fluid Statics:** - Pressure, Measurement of pressure using manometers, Hydrostatic law, Pascal's law, Pressure at a point, Total pressure, Centre of pressure, Pressure on a plane (Horizontal, vertical, Inclined) and Curved Surfaces, Archimedes's principle, Buoyancy and stability of floating and submerged bodies, Metacentric height. ,	08
Unit III **Fluid Dynamics:** - Introduction to Navier-Stroke's Equation, Euler equation of motion along a stream line, Bernoulli's equation, application of Bernoulli's equation to pitot tube, venturi meter and orifice meter. ,	08
Unit IV **Laminar And Turbulent Flow:** - Definition, Relation between pressure and shear stresses, Laminarflow through round pipe, turbulent flow and velocity distribution. **Dimensional Analysis:** - Dimensional Analysis, Dimensional Homogeneity, Rayleigh method & Buckingham's pi Theorem. ,	08
Unit V **Flow Through Pipes:** - TEL, HGL, Energy losses through pipe, Darcy-Weisbach equation, Minor losses in pipes, TEL, HGL, pipes in series and parallel, Siphons, Transmission of power. **Flow around Immersed Bodies:** - Lift and Drag, Classification of Drag, Flow around circular cylinder and Aerofoil, Development of lift on Aerofoil. ,	08

References:

Text Books Recommended:

1. Fluid Mechanics, Dr. R.K. Bansal, Laxmi Publication (P) Ltd. New Delhi
2. Engineering Fluid Mechanics, Kumar K.L., S. Chand & company Ltd. Eurasia
3. Fluid Mechanics & Hydraulic Machines, R.K. Rajput, S. Chand & Company Ltd.
4. Hydraulic and Fluid Mechanics, Modi P.N. and Seth S.M., Standard Book House.
5. Fluid Mechanics & Fluid Power Engineering – D. S. Kumar, S.K. Kataria & Sons

Reference Books Recommended:

1. Introduction to Fluid Mechanics, James E.A., John and Haberm W.A., Prentice Hall of India
2. Fluid Mechanics, Jain A.K., Khanna Publication
3. Fluid Mechanics, Manish R. Moroliya & N.Z. Adkane, Sara Book Publications.
4. Engineering Fluid Mechanics, Garde R.J. and Miraj Goankar, Nemchand & Bros,Roorkee, SCITECH,Publication (India) Pvt. Ltd.
5. Fluid Mechanics and Fluid Power Engineering, Dr. D.S. Kumar, S.K. Kataria& sons
6. Fluid Mechanics, Frank M. White, McGraw Hill Publication
7. Fluid Mechanics, Cengel & Cimbla, Tata McGraw Hill
8. Fluid Mechanics, Streeter V.L. and Wylie E.B., McGraw Hill International Book co.
9. Fluid Mechanics with Engineering Applications, E. Finnemore & Franzini, Tata Mc-Graw Hill
10. Hydraulic Machines-Theory and Design, V. P. Vasandani, Khanna Publishers
11. Fluid Mechanics, A. K. Jain, Khanna Publishers
12. Hydraulic & Compressible Flow Turbo-machines, A. T. Sayers, Mc-Graw Hill

RTM Nagpur University - Mechanical Engineering
B. Tech 3rd Semester
Kinematics of Machines (BTME304T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
III	Kinematics of Machines	3	-	-	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	Make student conversant with the process of motion transformation, develop ability to critically analyze the machines, mechanisms and controlling devices, and contrive newmechanisms.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Perform kinematic and dynamic analysis (Displacement, Velocity, acceleration, Inertia forces) of a given mechanism using graphical method.
CO2	Understand the concept of compliant mechanisms.
CO3	Contrive or synthesize new mechanisms for specific requirements.
CO4	Construct cam profiles and analysis the follower motion.
CO5	Understand Geometry of gear, its types, analysis of forces and motions of gear teeth. Study of gear trains.

SYLLABUS

Contents	No of hours
Unit I - INTRODUCTION Basic concept of mechanism, link, kinematics pairs, kinematics chain, mechanism, Difference between machine and mechanism, Inversions, machine, simple & compound chain, Degrees of freedom, Estimation of degree of freedom of mechanism by Grubber's criterion and other methods. Harding's notations, Classification of four bar chain , Class-I & Class-II, Kutzbach's criteria, Various types of mechanism such as Geneva wheel, Pawl and ratchet mechanism, Exact straight line mechanism, Approx. straight line mechanism, Pantograph mechanism. Introduction to compliant mechanisms	08
Unit II- KINEMATIC ANALYSIS Kinematic analysis of simple mechanisms using vector algebra (Graphical method), Concept of Corioli's component of acceleration. Velocity analysis using Instantaneous center of Rotation method, Kennedy's theorem.	08
Unit III – KINEMATIC SYNTHESIS a. Synthesis of mechanisms, Graphical b. Synthesis of mechanisms analytical technique. Restricted to design of crank rocker and slider crank mechanism only.	08
Unit IV - Cams and followers a. Types of cams and followers, types of follower motion, velocity and acceleration diagrams, Construction of cam profile. b. Introduction to cams with specified contours (No analytical treatment).	08
Unit V – Gears and Gear trains a. Classification of gears, Types of gears, Spur gears - terminology, conjugate gear tooth action and law of gearing, involute and cycloidal profile , contact ratio, Interference and under cutting, methods of avoiding interference, minimum number of teeth,. b. Helical gears: Nomenclatures, center distance, force analysis. Spiral Gears, Worm and worm Gears, Bevel Gears; their terminologies, center distance, force analysis and efficiency, Gear Trains.	08

References:

Text Books Recommended:

1. Theory of Machine, S. S. Rattan, Tata McGraw Hill.
2. Mechanism and Machine Theory, J.S. Rao & Dukki Patti, New Age International (P) Ltd, Publishers.
3. Theory of Machines, P L Ballaney, Khanna Publications.

Reference Books Recommended:

1. Theory of Machines and Mechanisms, J. E. Shigley and J. J. Uicker, Oxford University Press.
2. Theory of Machines, Sadhu Singh, Pearson publications.
3. Advanced Mechanism Design–Analysis and Synthesis, A.G.Erdman and G.N.Sandor, Vol. I and II,Prentice – Hall.
4. "Mechanisms and Mechanical Devices Source Book", Neil Sclater, Nicholas P Chrironis, McGraw-Hill.
5. Kinematics and Linkage Design, A. S. Hall, Jr., Prentice – Hall.
6. Mechanism Synthesis and Analysis, A. H. Soni, McGraw Hill.

RTM Nagpur University - Mechanical Engineering
B. Tech 3rd Semester
Machine Drawing and Solid Modeling (BEME305P)
Syllabus (Practical)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
III	Machine Drawing and Solid Modeling	-	1	2	2	50	50	100

Sr. No.	Course Objective The objective of this course is–
1	To make students conversant with machine drawing standards, techniques, symbols, notations, creation of 2-D and 3-D detailing of parts, GD&T, drawing reading, productiondrawing and process sheet.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Interpret and describe basic elements of standard machine drawing like lines, dimensions, tolerances, symbols etc.
CO2	Create 2-D detailing, sectional views of machine elements from given isometric view.
CO3	Understand and apply concepts of GD&T for creating part and assembly drawing.

SYLLABUS	
Contents	**No of hours**
Unit I **Basic Drawing Standards:** Drawing Sheets, Name Blocks, Types of Lines, Types of Dimensioning, Applying Tolerances, Standard Components and their representations, Standard Features, Machining Symbols, Welding Symbols, Surface Finish Symbols, Heat Treatment, Manufacturing Instructions, Allowances, Materials.	05
Unit II **Orthographic projections:** 2-D orthographic projection of machine elements, Sectional views, Dimensioning and detailing.	05
Unit III **GD & T:** Concepts of Limit, Fits and Tolerances (Standard, types, application and selection for assembly and manufacturing method), Surface Finish requirement for assembly, Manufacturing Method, Geometry suitable for assembly. Principals and practical applications of geometrical dimensioning andtolerance.	05

Sr. No.	List of Tutorials
01	Drawing Sheets, Name Blocks, Types of Lines, Standard dimensioning methods, Applying Tolerances.
02	Standard Components and their representations, Standard Features.
03	Machining Symbols, Welding Symbols, Surface Finish Symbols.
04	Heat Treatment, Manufacturing Instructions, Allowances, Materials.
05	2-D orthographic projection of machine elements
06	2-D orthographic projection of machine elements
07	Sectional views
08	Dimensioning and detailing.
09	Limit, Fits and Tolerances (Standard, types, application and selection for assembly and Manufacturing method)
10	Geometrical dimensioning and tolerances (symbols, applications) datum's, referencing.
11	Industrial Drawing Reading: Students to be give industrial (production) drawing of different components, they will be asked to study the drawing thoroughly, understand and interpret the meanings of symbol and notations and there importance.

References:

Text Books Recommended:

1. Naryana K.L., Kannaiah R., Venkata Reddy K "Machine Drawing", New Age Int.Pub.
2. Naryana K.L., Kannaiah R., Venkata Reddy K "Production Drawing ", New Age Int.Pub.
3. N.D.Bhatt "Machine Drawing; Ed", Charotar Publishing House.

Reference Books Recommended:

1. PSG College of Technology "Design data", DPV Printers, Coimbature, 1 2000.
2. "Engg. Drawing practice for schools & colleges", Bureau of Indian Standards, 1 Ed.; , 2002.st 1998

RTM Nagpur University - Mechanical Engineering
B. Tech 3rd Semester
Material Science and Engineering (BTME306T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
III	Material Science and Engineering	3	-	-	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	To impart Knowledge for analyzing different Microstructure and Crystalline nature of metals.
2	To impart knowledge of Iron-Iron carbide equilibrium diagram and microstructure ofcommercial steels and Cast Iron.
3	To provide the knowledge of various heat treatment processes.
4	To provide basic knowledge of non-ferrous alloys.
5	To impart basic knowledge of powder Metallurgy for Powder metallurgical components.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Student will be capable to distinguish micro structure and analyze the effect to crystalline nature of metals, construct and analyze Iron-Iron carbide equilibrium diagram.
CO2	Student will be able to study the commercial steels with their applications and properties.
CO3	Student will be able to analyze and implement suitable heat treatment processes.
CO4	Student will be able to analyze the Cast Iron and their properties.
CO5	Student will be able to perceive the basics of powder Metallurgy for powder metallurgical components.

SYLLABUS

Contents	No of hours
Unit I **Engineering Materials:** Classification, properties and applications of various engineering materials. Crystalline nature of metals, especially microscopic and macroscopic examinations of metals. Solidification of metals, cooling curves, alloys and solid solutions, types and their formations, modified Gibbs's phase rule, Lever rule for phase mixtures and their application in system. **Study of equilibrium diagrams:** Different phases and various invariant reactions in Iron-Iron carbide equilibrium diagram, critical temperatures. Microstructure of slowly cooled steels. Estimation of carbon from microstructures, structure property relationship as per the variations in carbon content.	08
Unit II **Plain Carbon Steels:** Classification and application of plain carbon steels. Alloy steels, examples of alloy steel, Effect of alloying elements on properties of steels, Austenite and ferrite stabilizers, Hadfield Manganese Steel, ball Bearing Steels, HCHC steels etc. **Tool Steels:** Classification, composition, application and commercial heat treatment practice for HSS, Secondary hardening, red hardness. **Stainless Steels** - Classification, composition, application and general heat treatment practice for Stainless Steels. Classification and applications of steels sensitization of stainless steels and weld decay.	08
Unit III **Heat treatment** and its importance. Annealing, Normalizing, Hardening, Quench Cracks, Hardenability test. Limitations of Fe-Fe3C diagram, TTT diagram and its construction and related Heat Treatment Processes such as Austempering, Martempering, and Patenting. Retained Austenite, Effects and elimination of retained austenite, Tempering. Case/Surface hardening treatments such as Carburizing, Nitriding, Cyaniding, Carbonitriding, Flame and Induction hardening. Hardenability test.	08
Unit IV **Cast Iron** – Classification, White cast Iron, Gray Cast Iron, Nodular Cast Iron, Malleable Cast Iron, and Chilled and alloy Cast Iron. (Production route, Composition, Microstructure and applications) Effects of various parameters on structure and properties of Cast Iron, Alloycast Iron such as Ni-resist, Ni-hard. **Non-Ferrous Alloys** – Study of non-ferrous alloys such as brasses (Cu-Zn diagram), defects in brasses, Bronzes (Cu- Sn diagram), Aluminum Alloys (e.g., Al-Si diagram),modified Al-Si diagram, Bearing materials.	08

Unit V	
Powder Metallurgy: Powder manufacture and Conditioning, Production of Sintered Structural Components, Self-lubricating bearing, Cemented Carbides, Ceramics, Sintered Carbide cutting tools. Process of powder metallurgy, advantages and limitations of powder metallurgy	08

References:

Text Books Recommended:

1. Material Science & Engineering, V.R.Raghavan, 1974.
2. Material Science & Engineering, WilliamCallister, 1985.
3. Material Science and Metallurgy for Engineers, V. D. Kodgire, 2011
4. Material Science& Engineering, R.K.Rajput, 2009.
5. Material Science& Engineering, An Introduction, 6th Edition, Donald Askeland, 1984.

RTM Nagpur University- Mechanical Engineering
B. Tech 3rd Semester
Skill Development -
(Basics of Computer Aided Drafting) (BTME307P)
Syllabus (Practical)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
III	Skill Development- (Basics of ComputerAided Drafting)	-	-	2	1	50	-	50

Sr. No.	COURSE OBJECTIVE
1	Students will be able to use Software (AUTOCAD) for creation of 2D models, and Drawings.

COURSE OUTCOME

Students will learn

- How to create simple parts, assemblies and drawings.
- How to use different feature-based tools to build, review and modify a model.
- How to create and analyze assemblies and how to produce a drawing with different views.
- Learn how to dimension the drawing and annotate the views.

Skill Development-(Basics of Computer Aided Drafting)
Contents
Module I: Sketcher - Creating Profiles. PLM Objects, Sketch Support, Simple elements, constraining sketches, simple and complexprofiles, transforming sketches, saving documents. Practice-1 : Hands on Session on Sketcher Workbench. Module II: Part Design -Creating Basic Features. Extruded Features, revolved features, holes, threads, taps, drafts, fillets, chamfers, shelling andstiffeners, relational dimensions. Practice-2 : Hands on Session on Sketch Based Features & Dress Up Features. Module III: Reviewing & Modifying. Measuring the model, re using the data, editing features. Practice-3 : Hands on Session on Measuring Tools & Editing Features. Module IV: Finalizing Design. Adding parameters, reusing features, rendering, weight calculation. Practice-4: Hands on Session on Parametric Design. Module V: Creating & Managing Products. Positioning Components, constraining Components, Analyzing weight distribution, replacing and revising parts. Practice-5: Hands on Session on Assembly Design. Module VI: Creating Drawings 4. Creating Drawing, Modifying, dimensioning, Annotations, Finalizing & Printing Practice-6 : Hands on Session on Drawing Conventions. Module VII: Master ExerciseHeat Sink, PC Card Slide. Practice-7 : Modeling of Heat Sink.
Text Books/ Reference Books/ Reference Material 1. Mechanical Design Fundamentals : Dassault Systemes Companion Learning Space Material

RTM Nagpur University - Mechanical Engineering
B. Tech 3rd Semester
SPORTS (BTME308P)
Syllabus (Practical)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
III	SPORTS	-	-	2	-	-	-	-

Sr. No.	COURSE OBJECTIVE
1	Through sports, students should able to build a wide range of abilities and skills such as leadership, confidence, teamwork, patience, self-reliance, trust, and many more which facilitate the overall development of an individual
2	Students should learn to manage time between their lectures, sports, and personal life.

EXPECTATION FROM INSTITUTES

1. Provide sports facilities
2. Provide platforms for participation in events
3. Develop interest for sports amongst students
4. Conduct regular events (every month) in college for all indoor and outdoor sports

RTM Nagpur University - Mechanical Engineering
B. Tech 3rd Semester
YOGA (BTME308P)
Syllabus (Practical)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
III	YOGA	-	-	2	-	-	-	-

Sr. No.	COURSE OBJECTIVE
1	To introduce basic wellness principles and practices of Yoga to students
2	To bring awareness of the fundamentals of Yoga for wellness in their daily lives
3	To bring peace and harmony in the society at large by introducing the Yogic way of life.

EXPECTATION FROM TRAINERS

1. Brief to origin of Yoga.
2. History and Development of Yoga: Vedic Period, Classical Period, Post classical period, Modern Period.
3. Etymology and Definitions of Yoga in classical Yoga texts.
4. Meaning, Aim and Objectives of Yoga.
5. Misconceptions about Yoga.
6. True Nature of Yoga.
7. Principles of Yoga.
8. Basis of Yoga.

RTM Nagpur University - Mechanical Engineering
B. Tech 3rd Semester
National Service Scheme (NSS) (BTME308P)
Syllabus (Practical)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
III	National Service Scheme (NSS)	-	-	2	-	-	-	-

COURSE OBJECTIVE

- Understand the community in which they work.
- Understand themselves in relation to their community.
- Identify the needs and problems of the community and involve them in problem-solving.
- Develop among them a sense of social and civic responsibility.
- Utilize their knowledge in finding practice solutions to individual and community problems.
- Develop competence required for group-living and sharing of responsibilities.
- Gain skills in mobilizing community participation.
- Acquire leadership qualities and democratic attitudes
- Develop capacity to meet emergencies and natural disasters.
- Practice national integration and social harmony

EXPECTATION FROM TRAINERS

1. To assist and guide the NSS unit for implementation of NSS programs at college level
2. To advise in organizing camps, training and orientation programs for the NSS volunteers
3. To visit the NSS units for monitoring and evaluation.
4. To ensure implementation of NSS regular activities and special camping programs

RTM Nagpur University- Mechanical Engineering
B. Tech 3rd Semester
National Cadet Corps (NCC) (BTME308P)
Syllabus (Practical)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
III	National Cadet Corps (NCC)	-	-	2	-	-	-	-

ABOUT NCC
1. NCC is the Indian military cadet corps wing of the Indian armed forces. 2. NCC offers training to the students of schools and colleges. 3. This is not compulsory training for all students.

Sr. No.	OUTCOMES EXPECTED
1	During the training of NCC, candidates should get the basic military training. This trainingshould be conducted to develop the interest of young students in all three forces; the army, the navy and the air force of India. Students should be able to check their abilitiesto join the Indian Defence Services.

Sr. No.	AIM
1	To create an organized, trained and motivated youth, create soldiers for the nation, develop the leadership skills in the youth.

EXPECTATION FROM INSTITUTES
• Create awareness amongst students about NCC • Make understand the students about the importance of NCC • Conduct regular Drills and Training exercises • Conduct Regular exams • Arrange for Training Camps

RTM Nagpur University-Mechanical Engineering
B.Tech 4th Semester
Machining Processes (BTME401T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
IV	**Machining Processes**	03	-	-	03	30	70	100	03

Sr. No.	Course Objective The objective of this course is–
1	Understand basic mechanism of metal removal processes.
2	Working mechanisms of various machine tools and machining principles.
3	To know surface finishing and allied processes.
4	Understand the importance of machining processes and be able to apply the suitable machining processes for an engineering product.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Understand fundamentals of metal cutting
CO2	Understand basic construction and operations of lathe shaping, planning
CO3	Understand basics of milling and milling cutters. slotting
CO4	To know about the surface finishing processes.
CO5	Understand the basic of drilling, boring, reaming and broaching.

Machining Processes (Theory) SYLLABUS	
Contents	No of hours
Unit I **Introduction to Machining Parameters**: Introduction to machining, Tool materials, nomenclature and tool geometry of single point cutting tool, tool materials properties, classification, HSS, carbide tool, coated tools, diamond coated tool. Theory of Metal Cutting: Introduction. Orthogonal and Oblique cutting. Mechanics of Metal Cutting. Merchant's circle, Chip formation, cutting force calculations, cutting fluids, cutting speed, feed and depth of cut on power requirement, Estimation of tool life.	09
Unit II Lathe: Introduction, types, construction of simple lathe, mechanism and attachments for various operations, machine specifications, basis for selection of cutting speed, feed and depth of cut, time estimation for turning operations such as facing, step turning, taper turning, threading, knurling. Introduction to Capstan, Turret Lathe and fundamentals of NC. **Shaper:** Introduction, types, specification, description of machines, cutting parameters. Mechanism of shaper: Quick return mechanism, Crank & slotted link mechanism, Table feed mechanism, attachments for shaper, work holding devices, shaper operations. **Planer:** Introduction, specifications, description, types of planner, open side planner, pit planner Mechanism for planner: Driving mechanism, feeding mechanism, planner cutting tools, cutting parameters.	10
Unit III **Milling:** Introduction. Specification, types, column & knee type milling machine, fixed bed type milling machines, production milling machines, special purpose milling machines such as thread milling Machines, profile milling machine, Gear Milling. Hobbing machines. Mechanisms & Attachments for Milling, Cutting parameters, Types of milling operations, Types of milling cutters, Tool geometry & their specifications. Indexing - simple, compound and differential. **Slotter:** Introduction, specifications, description, type of drives for slotter, types of slotting machines -production slotter, puncher slotter, tool room slotter, slotter tools.	09
Unit IV **Grinding**: Operations, grinding wheel, specifications & selection, cylindrical & centreless grinding operation, surface grinding, tool & cutter grinding, time estimation for grinding operations. **Super finishing process:** Honing, Lapping, super finishing, polishing, buffing, 'metal spraying, galvanizing and electroplating. Process parameters and attainable grades of surface finish, surface measurement.	09

Unit V **Drilling:** introduction, tools for drilling, classification of drills, twist drills, drill size and specifications, tipped drills, type of drilling machines-portable drilling machine. bench drilling machine, right drilling machine, radial drilling machine, universal drilling machine, multisided drilling machine. Drilling machines operations, time estimation for drilling. **Reaming:** Introduction, description of reamer, type of reaming operations. **Boring:** Introduction, types of boring machine, horizontal boring machine, vertical boring machine, jig machine, micro boring. boring operations. **Broaching:** Introduction, type of broaches, nomenclature of broaches. types of broaching machines.	09

Sr. No.	List of Tutorials
01	Based on above syllabus

References:

Text Books Recommended:

1. Workshop technology (Vol. II), V. S. Raghuwanshi, Dhanpat Rai & Sons
2. Manufacturing Science, Ghosh & Mallik, East West Press
3. Manufacturing technology (Metal cutting & Machine tools) Vol. II, P. N. Rao, Tata Mc-Graw Hill
4. Workshop technology, H. S. Bawa, Tata Mc-Graw Hill
5. Introduction to Manufacturing Processes, J. A. Schey, Tata Mc-Graw Hill
6. Workshop Technology (Volume II), Hajra Chaudhary, Media Promoters & Publishers

Reference Books Recommended:

1. Manufacturing Engineering & Technology, S. Kalpakjian & S.R. Schmid
2. Technology of Machine Tools, Krar & Oswald
3. Manufacturing Processes, M. Begman
4. Processes & Materials of Manufacture, R. Lindberg
5. Production Technology, HMT

RTM Nagpur University-Mechanical Engineering
B.Tech 4th Semester
Machining Processes Lab (BTME401P)
Syllabus (Practical)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
IV	Machining Processes Lab	-	-	02	01	25	25	50

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Understand basic cutting tools.
CO2	Working of lathe and turning operation
CO3	Shaping and planning operation
CO4	Milling and drilling operation
CO5	Grinding and surface finishing

List of Practical's

Minimum Eight out of following shall be performed:

Sr. No.	List of Practical's
01	Study of Single Point Cutting Tool.
02	Study of Various forces on single point cutting tools.
03	Study of multiple point cutting tools (milling, drilling)
04	Study of Lathe Machine.
05	Study of Shaper mechanisms.
06	Study of milling machine
07	One Job on Milling.
08	One Job on Drilling, Boring
09	One Job on Thread Cutting, Taper Turning.
10	One Job on Surface Grinding.

Suggested References:

1. Manufacturing Engineering & Technology, S. Kalpakjian & S.R. Schmid
2. Technology of Machine Tools, Krar & Oswald
3. Manufacturing Processes, M. Begman
4. Processes & Materials of Manufacture, R. Lindberg Production Technology, HMT

RTM Nagpur University-Mechanical Engineering
B.Tech 4th Semester
Hydraulic Machines (BTME402T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examinatio	Total	
IV	**Hydraulic Machines**	3	-	-	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	This course includes hydraulic turbines, centrifugal pumps, positive displacement pumps and miscellaneous water lifting devices
2	At the end of this course, students will understand practical applications of fluid; based on momentum and angular momentum principles involved in hydraulic machines.
3	Also understand design parameters and performance characteristics of various hydraulic machines & devices.
4	To learn more about power generation by using water

Course Outcomes

After successful completion of this course the student will be able to:

CO1	Classify turbomachine, components of HEPP, Design of Pelton wheel
CO2	Design of Francis and kaplan Turbine,Governing OF turbine
CO3	Design of centrifugal Pumps
CO4	Design of reciprocating Pumps
CO5	Learn miscellaneous Water Lifting Device

SYLLABUS	
Contents	No of hours
Unit I Theory of turbo machines and their classification, Elements of hydro-electric power plant, Impulse Turbine:- principle, constructional features, Installation of Pelton Turbine, Velocity Diagram and Analysis, Working proportions, Design parameters, Governing.	7
Unit II Reaction or pressure Turbine:- principles of operation, Degree of reaction, comparison over Pelton Turbine, Classification Of Draft tube, Cavitation in Turbine, Francis Turbine, Propeller Turbine, Kaplan Turbine:- Types, Constructional features, Installations, Velocity Diagram and analysis, Working proportions, Design parameters, Governing.	7
Unit III Centrifugal pumps:- Principle of operation, Classification, Component of Centrifugal Pump installation, Priming , Fundamental equation, Various heads, Velocity triangles and their analysis, or, Effect of outlet blade angle, Vane shapes, Losses and Efficiencies of pumps, Multi staging of pumps, Design Consideration, Working proportions, N.P.S.H., Cavitations in pumps ,	7
Unit IV Positive Displacement Pumps:- Basic principle, Classification, Reciprocating pump working,Design Main Components, Slip, % slip, negative slip, Work Done, Indicator Diagram, effect of acceration head and friction head on indicator diagram ,Cavitations, Air vessels,Seperation. ,	7
Unit V Miscellaneous Water Lifting Device: - Air lift pumps, Hydraulic Ram, Submersible pump, Regenerative pumps, Gear pump, screw pump, Vane pump	7

References:

Text Books Recommended:

1. Fluid Mechanics & Fluid Power Engineering – R.K.Rajput, S.Chand Publications

2. Fluid Mechanics & Machines – R. K. Bansal, Laxmi Publications

Reference Books Recommended:

1. Fluid Mechanics with Engineering Applications, E. Finnemore & Franzini, Tata Mc-Graw Hill

2. Hydraulic Machines-Theory and Design, V. P. Vasandani, Khanna Publishers

3. Fluid Mechanics, A. K. Jain, Khanna Publishers 4. Hydraulic & Compressible Flow Turbo-machines, A. T. Sayers, Mc-Graw Hill . Mechanics of Fluids, Merle C. Potter, CL-Engineering

6. Fluid Mechanics, John F. Douglas, Pearson

RTM Nagpur University-Mechanical Engineering
B.Tech 4th Semester
FLUID MECHANICS & HYDRAULIC MACHINES Lab (BTME402P)
Syllabus (Practical)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
IV	FLUID MECHANICS & HYDRAULIC MACHINES LAB	-	-	02	01	25	25	50

Course Outcomes	
After successful completion of this Practical course the student will be able to	
CO1	Explain what is Stability condition of floating bodies, Law of conservation of Energy.
CO2	Apply Frictional losses and Hydraulic co-efficient in the pipe flow.
CO3	Estimate the Performance characteristics of Pelton Turbine
CO4	Estimate the Performance characteristics of Francis Turbine & Kaplan Turbine.
CO5	Estimate the Performance characteristics of Centrifugal Pump & Reciprocating Pump.

Sr. No.	List of Practical's
01	To determine the metacentric height of given floating vessel.
02	To verify Bernoulli's theorem.
03	To find friction losses in pipe.
04	To find the value of co-efficient of given venture meter fitted in a pipe.
05	To find the value of co-efficient of Discharge for a given orifice meter.
06	Performance characteristics of Pelton wheel.
07	Performance characteristic of Francis Turbine.
08	Performance characteristic of Kaplan Turbine.
09	Performance characteristic of Variable Centrifugal speed pump
10	Performance characteristic of Reciprocating pump.
11	To find Reynold's Number

Suggested References:

1. Fluid Mechanics, Frank M. White, McGraw Hill Publication
2. Hydraulic Machines-Theory and Design, V. P. Vasandani, Khanna Publishers
3. Fluid Mechanics, John F. Douglas, Pearson
4. Introduction to Fluid Mechanics, James E.A., John and Haberm W.A., Prentice Hall of India

RTM Nagpur University-Mechanical Engineering
B.Tech 4th Semester
MECHANICS OF MATERIAL (BTME403T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
IV	MECHANICS OF MATERIAL	3	-	-	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	To study different types of stresses, strain and deformation induced in the mechanical components due to external loads.
2	To study Shear force and Bending moment, Stresses in beam under various loading conditions.
3	To understand phenomena of Deflection of Beam and Strain Energy.
4	To design and analyse shaft for various loading conditions
5	To understand design process and failure phenomena of Column & Struts.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Demonstrate fundamental knowledge about various types of loading and stresses induced
CO2	Draw the SFD and BMD for different types of loads and support conditions.
CO3	Estimate the strain energy in mechanical elements. And analyse the deflection in beams.
CO4	Can design shaft for various loading conditions.
CO5	Understand theory of failure and effective designing of column and Struts.

MECHANICS OF MATERIAL SYLLABUS (Theory)	
Contents	No of hours
Unit I Concept of simple stresses and strains: Introduction, stress, strain, types of stresses, stress and strain diagram for brittle & ductile material, elastic limit, Hooks law, modulus of elasticity, modulus of rigidity, factor of safety, analysis of tapered rod, analysis of composite section, thermal stress and strain. Longitudinal strain & stress, lateral stresses and strains, Poisson's ratio, volumetric stresses and strain with uni-axial, bi-axial & tri-axial loading, bulk modulus, relation between Young's modulus and modulus of rigidity, Poisson's ratio and bulk modulus Principal stresses and strains:- Definition of principal planes & principal stresses, analytical method of determining stresses on oblique section when member is subjected to direct stresses in one plane in mutually perpendicular two planes, when member is subjected to shear stress and direct stresses in two mutually perpendicular planes, Mohr's circle for representation of principal stresses ,	12 Hrs.
Unit II Shear force and bending moment: - Types of beam (cantilever beam, simply supported beam, overhung beam etc.), Types of loads (Concentrated and UDL), shear force and bending moment diagrams for different types of beams subjected to different types of loads, sign conventions for bending moment and shear force, shear force and bending moment diagrams for beams subjected to couple, Relation between load, shear force and bending moment. Stresses in beams: - Pure bending, theory of simple bending with assumptions & expressions for bending stress, derivation of bending equation, bending stresses in symmetrical sections, section modulus for various shapes of beam sections. Shear stresses in beams: - Concept, derivation of shear stress distribution formula, shear stress distribution diagram for common symmetrical sections, maximum and average shear stress. ,	10Hrs
Unit III Deflection of beams:- Deflection & slope of cantilever, simply supported, overhung beams subjected to concentrated load, UDL, Relation between slope, deflection & radius curvature Macaulay's method to determine deflection of beam. Strain energy & impact loading: - Definition of strain energy stored in a body when it is subjected to gradually applied load, suddenly applied loads & impact loads. Strain energy stored in bending & torsion . ,	12Hrs

Unit IV Torsion of circular shafts: - Derivation of torsion equation with the assumptions made in it. Torsion shear stress induced in the shaft, when it is subjected to torque. Strength and rigidity criterion for design of shaft. Torque transmitted by solid & hollow circular shaft. Equivalent twisting and bending moment in shaft when it is subjected to bending moment, torque & axial load.	8Hrs
Unit V Column & Struts: - Failure of long & short column, slenderness ratio, assumptions made in Euler's column theory, end conditions for column. Expression for crippling load for various end conditions of column and derivation on column with both ends hinged. Effective length of column, limitations of Euler's formula, Rankine formula.	4Hrs

Sr. No.	List of Tutorials
01	problems on simple and principle stresses
02	problems on Mohr's circle
03	problems on Thermal stresses
04	problems on S.F. & B.M. diagrams
05	problems on Stresses in beam bending
06	problems on shear stresses
07	problems on Macaulay's methods
08	problems on shafts
09	problems on columns & struts

Assignments (Guidelines)

At least one problem on the following topic

1. Stresses in Beams (A two wheeler chassis design concept)
2. Strain energy and deflection (Determination of equivalent load due to impact on the component and its design)
3. Torsion , Column and Struts (Design of frames of solar PV roof top system using software like Stat-Pro)

Note: Preferably The assignments shall be based on live problems. Project based learning may be incorporated by judiciously reducing number of Assignments

References:

Text Books Recommended:

1. Strength of Materials by S. Ramamrutham and R. Narayanan, Dhanpat Rai Publishing Company (P) Ltd, 18th Edition 2017.

2. Strength of Materials by R.K. Bansal, Laxhmi Publications , New Delhi, 6th edition, 2017

3. Strength of Materials by S.S.Rattan, Mcgraw Hill Education, 3rd edition , 2016

Reference Books Recommended:

1. Mechanics of Materials By Beer , Johnston, Dewolf and Mazurek , Tata McGraw- Hill Education , 7th edition , 2015

2. Elements of Strength of Materials by Timoshenko, S.P. and Young, D.H., East West Press, 5th edition, 2011

RTM Nagpur University-Mechanical Engineering
B.Tech 4th Semester
Material Testing Lab (BTME403P)
Syllabus (Practical)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
IV	Material Testing Lab	-	-	2	1	25	25	50

Sr. No.	Course Objective The objective of this course is–
1	Create specimen for metallographic examination.
2	Analyze the microstructure and investigate various properties of ferrous and nonferrous Materials.
3	Test different Engineering Materials.
4	Analyze the hardenability microstructure.
5	Test Cast Iron.
6	To familiarize material behavior under different loading conditions
7	To acquaint with surface hardness measurement method
8	To familiarize with impact test methods for different materials
9	To study and analyze deflection of beams in various loading conditions.
10	To study and understand behavior of material under various loading conditions.

Course Outcomes

After successful completion of this course the student will be able to:

CO1	Analyze the Microstructure and investigate various properties of ferrorous and Non ferrous Materials . Analyse the stress strain behaviour of materials
CO2	Analyse the effect of tensile, shearing force and can utilized the gained while tackling real life engineering problems for different types of Materials
CO3	Understand Microstructures and their Applications for various uses
CO4	Measure torsional strength , hardness of material
CO5	Incorporate the various important concepts learnt while designing components

****NOTE**: At least 10 Experiments should be included in the Journal-At least 5 from Serial Number 1 to 7 and at least 5 from serial Number 8 to 14). This Practical load shall be equally shared by subject teachers handling subjects Material Science & Engineering and Mechanics of Materials.

Sr. No.	Material Testing Lab -List of practical's
01	To study the Metallurgical Microscopes & Preparation of specimen for metallographic examination.
02	Micro-structural examination of different types of Steels
03	Micro-structural study of White Cast Iron and Grey Cast Iron
04	Micro-structural study of Malleable Cast Iron and Nodular Cast Iron
05	Study of Universal Testing Machine
06	Determination of tensile properties of ductile material
07	Determination of properties of brittle material
08	Compression test on materials
09	Shear test on metals
10	Impact test on materials
11	Torsion test of metal shaft
12	Determination of bending strength by deflection of beam
13	Measurement of hardness with the help of Rockwell Hardness Tester
14	Measurement of hardness with the help of Brinell Hardness Tester

RTM Nagpur University-Mechanical Engineering
B.Tech 4th Semester
Engineering Thermodynamics (BTME404T)
Syllabus(Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
IV	Engineering Thermodynamics	3	-	-	3	30	70	100	03

Sr. No.	Course Objective The objective of this course is–
1	This course deals with the fundamentals of Thermodynamics, including thermodynamic systems and properties, relationships among the thermos-physical properties, the laws of thermodynamics and applications of these fundamental laws in thermodynamic systems
2	To present a comprehensive and rigorous treatment of classical thermodynamics while retaining an engineering perspective.
3	Explain the working principle of various power cycles used in thermal systems.

Course Outcomes	
After successful completion of this course, the student will be able to:	
CO1	**Explain** thermodynamics concepts, **relate** laws of the ideal gas, **identify** various thermodynamic processes and apply the laws to **determine** the energy transfer in terms of heat and work.
CO2	**Explain** the first law of thermodynamics and **apply** the law to **evaluate** open, closed systems, thermal components and devices.
CO3	**Interpret the** second law of thermodynamics, entropy, and apply the law to evaluate heat engine, heat pump, and refrigerator performance.
CO4	**Relate** various steam properties, and **analyze** the different types of processes using steam as working fluid to **determine** the energy transfer in terms of heat and work.
CO5	**Compare** various power cycles and **analyze** the cycles to **determine** the energy transfer in terms of heat, work and efficiency.

Engineering Thermodynamics Syllabus	
Contents	No of hours
Unit I Basic concepts of Thermodynamics, Systems and their types, Property, State, Process, Phase, Cycles. Comparison of microscopic and macroscopic approaches. Path and point functions. Thermodynamic Equilibrium. Zeroth law of thermodynamics and its significance for temperature measurement Introduction to First law of thermodynamics, Energy transfer, Heat and work transfer. Ideal Gas laws: Boyle‟s law, Charle‟s law, Gay-Lussac‟s law, Avagadro‟s law, Equation of state, General gas equation, Specific Heat, Universal gas constant. Thermodynamic Processes: Constant pressure, Constant volume, Isothermal, Isentropic and Polytropic process, representation on P-V and T-s Diagram, Calculation of Heat transfer, Work done, Change in Internal Energy and Enthalpy for these processes.	10
Unit II The first law of Thermodynamics for Closed System undergoing a process and cycle (Control Mass System) and Open System (Control Volume System) Steady Flow process applies to Compressor, Pump, Turbine, Boiler, Steam Nozzle, Throttling Device, Heat Exchanger, Fan and blower. (Analytical treatment on First law applied to thermodynamic processes and cycles and Steady low energy equation applied to various flow devices is expected). ,	9
Unit III Second Law of Thermodynamics:- Heat Reservoir, source and sink. Heat Engine, Refrigerator, Heat Pump, Kelvin-Plank and Clausius Statements, Perpetual Motion Machine I and II, Carnot Cycle, Thermodynamic Temperature scale. Entropy:- Clausius Inequality, Entropy, Principle of Increase of Entropy, Change in Entropy for different thermodynamics processes with T-S Diagram, Reversible and Irreversible Processes. (Simple analytical treatment on COP calculation is expected) ,	9
Unit IV Properties of Steam:- Formation of steam and its thermodynamic properties like Sensible Heat, Latent Heat, Critical State, Triple Point, Wet Steam, Dry Steam, Superheated Steam, Dryness Fraction, Enthalpy, Internal Energy of Steam, External Work Done during Evaporation, T-S Diagram, Mollier Chart, Work and Heat Transfer during various Thermodynamic Processes with steam as working fluid. Measurement of Dryness Fraction using various Calorimeters. (Analytical Treatment using steam table and Mollier chart is expected) ,	9

Unit V Power Cycles: - Otto Cycle, Diesel Cycle, Dual Cycle, Brayton Cycle, Representation on P-v and T-s diagrams. The equation for work done, heat transfer, air standard efficiency, and mean effective pressure. Comparison of Otto, Diesel and Dual cycles. Introduction to simple vapour power cycle, i.e., Rankine cycle (Analytical treatment in terms of calculation Work done & efficiency analysis is expected on Otto Cycle, Diesel Cycle and Dual Cycle)	9
Total Hours	46

Sr. No.	List of Tutorials
01	Application of first law to control mass (closed system) system
02	Application of first law to control volume (open system) system
03	Determination of Heat transfer, Work done, Change in Internal Energy and Enthalpy of various thermodynamic processes and cycles.
04	Determination of various properties of steam by using Steam table and Mollier chart
05	Application of second law to heat engine, refrigerator and heat pump.
06	Thermodynamic analysis of Otto cycle.
07	Thermodynamic analysis of Diesel cycle.
08	Thermodynamic analysis of Dual cycle and Brayton cycle.

References:

Text Books Recommended:

1. Engineering Thermodynamics, P. K. Nag, Tata McGraw-Hill Publications
2. Thermodynamics, S. C. Gupta, Pearson Publications
3. Thermal Engineering, P. L. Ballani, Khanna Publications
4. Engineering Thermodynamics, S.S. Khandare, Charotar Publication House
5. Engineering Thermodynamics, R. K. Rajput, Laxmi Publication

Reference Books Recommended:

1. Thermodynamics and Engineering approach, Yunus A. Cengel, Michael A. Boles, Tata McGraw-Hill Publications
2. Engineering Thermodynamics, D. P. Mishra, Cengage Learning Publications
3. Engineering Thermodynamics, Gordon Rogers, Pearson Publications

RTM Nagpur University-Mechanical Engineering
B.Tech 4th Semester
Computer Programming (BTME405P)
Syllabus(Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assess	University Exam	Total	
IV	Computer Programming	-	1	2	2	25	25	50	-

Sr. No.	Course Objective The objective of this course is–
1	To to apply knowledge of basic concepts of programming in C to solve mechanical Engineering problems
Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Understand and explore concepts in basic programming like data types, input/output functions, operators, programming constructs and user defined functions.
CO2	Develop capabilities of writing „C“ programs in optimized, robust and reusable code
CO3	Apply appropriate concepts of data structures like arrays, structures implement programs for various applications

Computer Application/Programming SYLLABUS	
Contents	No of hours
Introduction to C programming: Basic structure of C program, Features of C language, Character set, C tokens, Keywords and Identifiers, Constants, Variables, Data types	05
Operators and Expressions: Arithmetic operators, Relational operators, Logical Operators, Assignment operators, Increment and decrement operators, Conditional operators, Bit-wise operators, Arithmetic expressions. Evaluation of expressions, Precedence of arithmetic operators, Type conversion in expressions, Operator precedence and associativity.	05
Decision Making: Decision making with 'if' statement, Simple 'if' statement, the 'if…else' statement, nesting of 'if…else' statements, The 'else if' ladder, The 'switch' statement. The while statement, The do while statement, The 'for' statement, Jumps in loops.	05
Arrays: One dimensional arrays, Declaration of one dimensional arrays. Initialization of one dimensional arrays, Two dimensional arrays, Initializing two dimensional arrays. Declaring and Initializing String Variables, Reading Strings from Terminal, Writing strings to screen, String handling functions	05
User-defined functions: Need for User Defined Functions, Definition of functions, Return values and their types, Function calls, Function declaration. **Introduction to Pointers:** Introduction, Declaration and initialization of pointers. Examples Structures and Unions: Introduction, Structure and union definition, Declaring structure and union variables, Accessing structure members.	05

Sr. No.	Computer Application/Programming (List of Practical)
01	Development of programs in C To find area/surface area, volume for Planes, Solids. (Applications for cost involved for painting surface of any plane(square, rectangular, hexagonal etc), costing based on metal sheet material required for manufacturing cylinder(ends open/closed/one end open), cone, cube etc. with varying quantity of products)
02	Development of programs in C To find Stress with given force and cross sectional

	area(square, rectangle, circular etc)
03	Development of programs in C To find angular velocities and acceleration of the output and coupler link for four bar chain mechanism.
04	Development of programs in C for given inner, outer radii for single plate clutch and axial force calculate minimum, maximum, and average pressure acting on clutch plate.(or calculating inner outer radii, width of friction lining, axial force etc. for single/multi plate clutch or similar type of simple calculation programme for block brake.
05	Development of programs in C for Addition, Multiplication Matrices.
06	Development of programs in C for any Numerical methods like Newton Raphson, Gauss-Elimination, Gauss-Jordan, Crout's method and Gauss-Seidel Method. Development of programs in C / C+ + for any Numerical methods like Taylor's series method, Runge Kutta method, Euler's modified method, Milne's predictor corrector method, Iterative methods for eigen value & eigen vector determination.
07	Development of programs in C To determine type of flow of fluid(laminar/turbulent/transient) on the basis of Reynolds's Number
08	Development of programs in C To calculate specific density, specific weight, weight if specific gravity is given for liquid

Note: During University practical examination of 50 marks, students are expected to prepare & execute computer programs in C of total 30 marks in one hours duration. Viva-Voce of 20 marks shall be conducted during University practical examination.

References:

Text Books Recommended:

1)Programming in C , P. Dey, M. Ghosh, First Edition, 2007, Oxford University press, ISBN (13): 9780195687910.

2. The C Programming Language, Kernighan B.W and Dennis M. Ritchie, Second Edition, 2005, Prentice Hall, ISBN (13): 9780131101630.
3. Turbo C: The Complete Reference, H. Schildt, 4th Edition, 2000,Mcgraw Hill Education, ISBN-13: 9780070411838.
4. Understanding Pointers in C, Yashavant P. Kanetkar, 4th Edition, 2003, BPB publications, ISBN-13: 978-8176563581
5. C IN DEPTH, S.K Srivastava, Deepali Srivastava, 3rd Edition, 2013, BPB publication, ISBN9788183330480

Reference Books Recommended:

1. An Introduction to Data Structures with Applications, Trembly J. P. And Sorenson P. G., Tata McGraw Hill Pub. Co. Ltd.
2. Fundamentals of Computer Algorithms, Horowitz E. And Sahani S., Galgotia Publications Ltd.
3. Programming in C, Gotterfield B., Schaums Outline Series. 4. Mastering C, R. Venu Gopal Prasad, Tata McGraw Hill Pub. Co. Ltd.

RTM Nagpur University-Mechanical Engineering
B.Tech 4th Semester
Professional Ethics (BTME406T)
Syllabus(Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
IV	**Professional Ethics**	3	-	-	3	30	70	100	03

Sr. No.	Course Objective The objective of this course is–
1	The objective of this course is to inculcate the sense of social responsibility among learners and to make them realize the significance of ethics in professional environment so as to make them a global citizen

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Understand basic purpose of profession, professional ethics and various moral and social issues
CO2	Analyze various moral issues and theories of moral development
CO3	Realize their roles of applying ethical principles at various professional levels
CO4	Identify their responsibilities for safety and risk benefit analysis.
CO5	Understand their roles in dealing various global issues

Professional Ethics SYLLABUS (Theory)	
Contents	No of hours
Unit I Human Values, Morals, values and Ethics, Integrity, Work ethics, Service learning, Civic virtue, Respect for others, Living peacefully, Caring, Sharing, Honesty, Courage ,	08
Unit II Engineering Ethics, Senses of 'Engineering Ethics', Variety of moral issues, Moral dilemmas, Moral Autonomy, Kohlberg's theory, Gilligan's theory ,	07
Unit III Engineering as Social Experimentation, Engineering as Experimentation, Engineers as responsible Experimenters, Codes of Ethics, A Balanced Outlook on Law ,	07
Unit IV Safety, Responsibilities and rights, Safety and Risk, Assessment of Safety and Risk, Risk Benefit Analysis and Reducing Risk, Collective Bargaining, Professional Rights, Employee Rights	07
Unit V Global issues, Multinational Corporations, Computer Ethics, Weapons Development, Engineers as Managers, Consulting Engineers, Engineers as Expert Witnesses and Advisors, Corporate Social Responsibility	07

References:

Text Books Recommended:

1. Professional Ethics by R. Subramaniam – Oxford Publications, New Delhi.
2. Human Values And Professional Ethics by Jayshree Suresh and B. S. Raghavan, S. Chand Publications
3. Ethics in Engineering by Mike W. Martin and Roland Schinzinger – Tata McGraw-Hill – 2003.
4. Human Values & Professional Ethics by S. B. Gogate, Vikas Publishing House Pvt. Ltd., Noida.
5. Professional Ethics and Human Values by A. Alavudeen, R.Kalil Rahman, and M. Jayakumaran – University Science Press.
6. Engineering Ethics & Human Values by M.Govindarajan, S.Natarajan, and V.S.SenthilKumar-PHI Learning Pvt. Ltd – 2009.
7. Professional Ethics and Human Values by Prof.D.R.Kiran-Tata McGraw-Hill – 2013

RTM Nagpur University-Mechanical Engineering
B.Tech 4th Semester
Skill Development (Training on Matlab) (BTME407P)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
IV	Skill Development (Training on MATLAB)	-	-	2	1	50	-	50	-

Course Objective

This helps it create a simple environment for solving problems. This easy-to-use environment helps engineers solve high-level problems. It also makes it easier for them to express problems in a mathematical form. The most common uses of MATLAB include computation, development, prototyping and visualization

Course Outcomes

After successful completion of this course the student will be able to use MATLAB to develop, design, simulate, and test their models before it can be developed in the real world. In the field of mechanical engineering, MATLAB will be used for solving problems related to dynamic and static systems, mechanical vibrations, control systems, statics, and more.

Contents- MATLAB- IV Sem- Mechanical Engineering

References:

Text Books Recommended:

1. Timothy A. Davis, MATLAB Primer, 8e, University of Florida, Chapman & Hall/CRC, 2011, ISBN: 978-1-4398-2862-5; Language: English
2. S Kermit, MATLAB Primer, 3e, University of Florida
3. Primer, MATLAB , MathWorks, Inc, 30e

References:

Text Books Recommended:

1. Timothy A. Davis, MATLAB Primer, 8e, University of Florida, Chapman & Hall/CRC, 2011, ISBN: 978-1-4398-2862-5; Language: English
2. S Kermit, MATLAB Primer, 3e, University of Florida
3. Primer, MATLAB , MathWorks, Inc, 30e

RTM Nagpur University- Mechanical Engineering
5TH SEM-Heat Transfer-BEME501T
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
B.Tech 5th Sem Mechanical	**Heat Transfer**	3	1	0	04	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	This course is designed to learn the different modes of heat transfer like conduction, convection & Radiation and formulation of problem based on required application.
2	It will help students to distinguish between steady and unsteady state heat transfer and their applications will enable to calculate heat transfer rate from different geometry of the system under free and forced convection.
3	It also aims to impart knowledge to analyse radiation with and without radiation shield. In addition, it also discusses methods to analyse & design heat exchangers.
4	In all to generate interest in learning to develop in depth understanding in Heat Transfer.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Students will be able to define and compare the different modes of heat transfer and calculation of thermal resistance and heat transfer through plane and composite wall, cylinder and sphere with and without thermal contact resistances.
CO2	Students will be able to apply the concept of internal heat generation for the calculation of heat transfer for plane wall, cylinder and sphere and also learn about various types of fins and their significance in steady state conduction heat transfer calculations. It will also help them to understand the concept of unsteady state heat transfer.
CO3	Students will be able to select and apply appropriate empirical correlations to estimate forced convection and free convection heat transfer, for internal and external flows.
CO4	Students will be able to evaluate heat transfer rate by radiation from ideal and actual surfaces and enclosures of different geometries.
CO5	Students will be able to evaluate heat exchanger performance for the given geometry and boundary conditions and design suitable heat exchanger geometry to deliver a desired heat transfer rate.

SYLLABUS- Heat Transfer	
Contents	No of hours
Unit I Introduction, Basic modes of Heat Transfer, Conduction, Convection & Radiation. Laws of Heat transfer , General heat conduction equation in Cartesian, Cylindrical and Spherical coordinates. One dimensional steady state heat conduction equation for the plane wall, cylinder and sphere, Overall heat transfer coefficient. Thermal resistance of composite structure, contact resistance, variable thermal conductivity, critical thickness of insulation. ,	10
Unit II Conduction with internal heat generation for plane wall, Cylinder and Sphere, Extended surface, Types of Fins, Fins of uniform cross section area, temperature distribution and their heat transfer rate, Fin efficiency & Effectiveness. Unsteady state heat transfer, lumped heat capacity analysis, Heisler's charts. Biot's Number, Fourier's Number & its significance. Approximate solution to unsteady state conduction heat transfer by the use of Heisler's chart	09
Unit III Forced convection, Concept of hydrodynamics & thermal boundary layer thickness, local and average heat transfer coefficient. Empirical co-relations for external, internal flows, laminar & turbulent flow through conduits. Free or Natural Convection, Grashof's number, Rayleigh number, flow over horizontal and vertical plate, Empirical co-relations for cylinders and sphere. Introduction to cooling of electronic devices. Heat transfer enhancement using nano fluids. Boiling and Condensation heat transfer: Pool boiling curve and regimes of pool boiling, Film and Drop wise condensation	09
Unit IV Radiation, spectrum of radiation, black body radiation, radiation intensity, Laws of radiation-Kirchhoff, Planck's, Wien's displacement law, Stefan Boltzmann & Lamberts Co-sine law. Emissivity, Absorbtivity, Transmisivity, Reflectivity, Radiosity, Emissive power, Irradiation. Radiation exchange between surfaces, shape factor & its laws, radiation between parallel plates, cylinder & spheres. Radiation shields	09

Unit V Heat exchanger: Detail Classification, Overall Heat Transfer Coefficient, Fouling Factor, LMTD & Effectiveness -NTU method of heat exchanger analysis for parallel, counter flow & cross flow arrangement, Introduction to compact heat exchanger, Heat Pipe. ,	09

Books Recommended:

Text Book

1. Fundamentals of Heat & Mass Transfer, Incropera, F.P., Dewitt, D. P., John Wiley & Sons .
2. Heat Transfer, J.P. Holman, McGraw Hill Book Company, New York.
3. Fundamentals of Heat and Mass Transfer, K. N. Seetharam & T.R. Seetharam, Willey.
4. Engineering Heat and Mass Transfer, M.M. Rathor, Laxmi PublicationsPvt. Ltd.

Reference Book

1. Fundamentals of Heat and Mass Transfer, Venkanna B.K., PHI Publication.
2. Principles of Heat Transfer, Frank Kreith, Harper and Row Publishers, New York.
3. Heat Transfer - A Practical Approach, Yunus A. Cengel, Tata McGraw Hill Publishing Company Ltd., New Delhi.
4. Heat & Mass Transfer, M.N. Ozisik, Tata McGraw Hill Publishing Company Ltd., New Delhi.
5. Heat & Mass Transfer, R.K. Rajput, Laxmi Publication.

DATA BOOK: 1. Heat & Mass Transfer, Domkundwar, Dhanapat Rai & Sons Publication.
2. Heat & Mass Transfer, C.P.Kothandaraman,PHI publishers.

Sr. No.	List of Tutorials
01	Calculation of thermal resistance and heat transfer through plane and composite wall, cylinder and sphere with and without thermal contact resistances.
02	Calculation of critical thickness of insulation and change in heat transfer for cylindrical and spherical wall.
03	Calculation of heat transfer coefficient and heat transfer rate from plane wall, cylinder and duct subjected to internal and external flow under forced convection.
04	Calculation of heat transfer coefficient and heat transfer rate under free convection
05	Calculation of shape factor for different configuration of grey bodies.
06	Calculation of overall heat transfer coefficient using LMTD and NTU methods

RTM Nagpur University- Mechanical Engineering
5TH SEM -Heat Transfer Lab (BEME501P)
Syllabus (Practical)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
B.Tech 5th Sem Mechanical	**Heat Transfer Lab**	-	-	02	1	25	25	50

Sr. No.	Course Objective The objective of this course is–
1	To demonstrate and perform basic principles finding thermal conductivity of various materials like asbestos, brass etc.
2	To demonstrate basic method for determination of overall heat transfer coefficient of composite slabs.
3	To perform experimentation for determination of heat transfer coefficients in free and forced convection.
4	To demonstrate basic method for determination of emissivity of grey body and Stefan Boltzmann's constant.
5	To perform experimentation for determination of heat transfer coefficients, effectiveness and heat transfer rates in Heat Exchangers

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Students will be able to determine the heat transfer rates through various cross-sections and mediums in different modes.
CO2	Student will be able to acquire, tabulate, analyze experimental data, and draw interpretation and conclusions
CO3	Student will be able to calculate radiation heat transfer and utilize that knowledge in designing any heat transfer application .
CO4	Student will be able to understand heat exchanger analysis.

Sr. No.	List of Practical's -Heat Transfer Lab
01	To determine the thermal conductivity of insulating material.
02	To determine the thermal conductivity of metal bar.
03	Determination of thermal conductivity of composite wall.
04	Determination of Stefan Boltzmann constant.
05	Determination of heat transfer coefficient in natural convection for vertical tube.
05	To determine heat transfer coefficient in forced convection for fluid flowing through a duct
06	Determination of temperature distribution & heat transfer rate from fin under free and forced convection.
07	Determination of emissivity of non-black body.
08	To determine the effectiveness of a concentric tube heat exchanger.
09	To determine the critical heat flux.
10	Determination of heat transfer rate in unsteady state heat transfer.
11	To determine the heat transfer coefficient in filmwise and dropwise condensation.
12	Determination of performance of shell and tube heat exchanger using computer-based setup
12	Minimum 2-3 virtual experiment to be conducted.
13	Study of various types of Heat Exchangers.
14	Study of Heat Pipe.

Note : At least 8 practicals from the above list are expected.

RTM Nagpur University- Mechanical Engineering
5TH SEM-Energy Conversion -I -BEME502T
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
B.Tech 5th Sem Mechanical	**Energy Conversion-I**	3	1	-	4	30	70	100	03

Sr. No.	Course Objective The objective of this course is–
1	To expose the students to the practical applications of engineering thermodynamics & working of steam power plants.
2	To gain the knowledge of various components of the thermal power plant like boiler, nozzles, turbines and condensers and will be able to evaluate the performance parameters of these components.
3	To understand the concept of utilizing residual heat in thermal systems
Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Explain, classify, analyze layout of power plant, cogeneration principle of steam generators (i.e. Boilers), boiler mountings & accessories and evaluate performance parameters of boiler.
CO2	Explain the concepts of fluidized bed boilers and various draught system and evaluate performance parameters of natural draught system(i.e. chimney)
CO3	Explain the importance of steam nozzle and determine its throat area, exit area, exit velocity. Also compare impulse and reaction steam turbines and explain the concept of governing of steam turbine
CO4	Explain the methods of compounding of steam turbine, various energy losses in steam turbine and able to draw velocity diagrams of steam turbine blades to analyze the angles of the blades, work done, thrust, power, efficiencies of turbine.
CO5	Explain, classify steam condensers, cooling towers and evaluate performance parameters of surface condenser.

Syllabus- Energy Conversion–I (Theory) , Mechanical Engineering, V Sem	
Contents	No of hours
Unit I Introduction to layout of thermal power plant, Coal handling system and ash handling systems. Classification of steam generators (i.e. Boilers), comparison of fire tube & water tube boilers, high pressure boilers, boiler mountings and accessories. Principle of steam generation, necessity of water treatment, Performance of steam generators: Evaporation capacity, equivalent evaporation, boiler efficiency and preparation of Heat balance sheet of boiler. Cogeneration: Introduction to cogeneration, its need, working principle and applications. Topping cycle and bottoming cycle.	12
Unit II Draught and its classification, calculations for chimney height, chimney diameter & efficiency. Condition for maximum discharge. Fluidized bed boiler: Bubbling fluidized bed boilers, circulating fluidized bed boilers (Elementary treatment expected)	8
Unit III Steam nozzles: Adiabatic expansion in nozzles, maximum discharge, critical pressure ratio and effects of friction, calculation of throat, exit areas and exit velocity of nozzle, supersaturated flow, Wilson Line. Steam turbines: Working principle of steam turbines, classification of steam turbines, and comparison of impulse and reaction turbine, governing of steam turbines. ,	8
Unit IV Compounding of steam turbines, Energy losses in steam turbines, flow of steam through turbine blades, reheat factors, velocity diagrams, graphical and analytical methods, work done, thrust and power, dimensions and proportioning of the blades, steam turbine efficiencies, condition for maximum efficiencies. (Analytical Treatment on Impulse turbine, Reaction turbine and two stage impulse turbine is expected) ,	8
Unit V Steam condensers: Classification of condensers, quality and quantity of cooling water required, calculations for surface condenser, Dalton's law of partial pressure, sources of air leakages and air removal, air ejectors. Cooling towers: Natural draught and forced draught cooling towers, cooling ponds ,	8
TOTAL HOURS	44

Sr. No.	List of Tutorials- Energy Conversion –I
01	Two problems on determination of factor of evaporation, equivalent evaporation and boiler efficiency of steam generators (i.e. boilers.)
02	Two problems on preparation of Heat balance sheet of boilers.
03	Two problems on determination of height and diameter of chimney.
04	Two problems on calculation of throat, exit areas and exit velocity of nozzle.
05	One problem on metastable or supersaturated flow through nozzle
06	Two problems on determination of blade angles, work done, thrust, power, efficiencies of Impulse turbine.
07	Two problems on determination of work done, thrust, power, efficiencies of Reaction turbine.
08	One problem on determination of power and efficiencies of two stage Impulse turbine
09	Two problems on calculation of performance parameters of surface condenser.

References:

Text Books Recommended:

1. A Course in Power Plant Engineering, Arora & V.M. Domkundwar, Dhanpat Rai & Sons
2. Thermal Engineering, P.L. Ballaney, Khanna Publications.
3. Thermal Engineering, R. K. Rajput, Laxmi publications.
4. Thermal Engineering, M.M. Rathode, TMH publication.
5. A Course in Thermal Engineering, Anand Domkundwar, C.P. Kothandaraman, S.Domkundwar, Dhanpat Rai & Sons.

.**Reference Books Recommended:**

1. Thermal Engineering, Mathur & Mehtra, Jain Brothers Publications, New Delhi.
2. Heat Engineering, V.P. Vasandani & D.S. Kumar, Metropolian Book Publishers.
3. Power Plant Engineering, A.K. Raja, Shrivastava and Dwivedi, New age International Publishers.
4. Fluidized Bed Combustion, S. Oka and E. Anthony, Marcel Dekker Inc.
5. Power Plant Engineering, M. M. EI- Wakil, McGraw Hill International.
6. Charles H Butler: Cogeneration" McGraw Hill.
7. Donald Q. Kern, "Process Heat Transfer", Tata Mc Graw Hill.
8. Sydney Reiter "Industrial and Commercial Heat Recovery Systems" Van Nostrand Reinhols.

RTM Nagpur University- Mechanical Engineering
5th Semester
Design of Machine Elements –(BEME503T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
B.Tech 5th Sem Mechanical	**Design of Machine Elements**	3	1	-	4	30	70	100	3 Hours

Sr. No.	Course Objective The objective of this course is–
	To study the basic principles of mechanical components design based on strength and rigidity using design data, various standards, codes, etc. and prepare component drawings.

Course Outcomes

After successful completion of this course the student will be able to:

CO1	Apply principals of static loading for design of Cotter joint, Knuckle joint
CO2	Design bolted, welded joints, power screws & pressure vessels
CO3	Design the power transmission shaft & coupling
CO4	Design components subjected to fatigue or fluctuating stresses. Also, will be able to apply principles for determining bending stresses for desing of curved beams e.g. crane hook, C-Frame.
CO5	Design clutches, brakes and springs

Syllabus- Design of Machine Elements (Theory,) 5th Semester , Mechanical Engineering	
Contents	No of hours
Unit I Mechanical Engineering Design, Design methods, Aesthetic and Ergonomics consideration in design, Material properties and their uses in design, Manufacturing consideration in design, Design consideration of casting and forging, Basic principle of Machine Design, Modes of failures, Factor of safety, Design stresses, Theories of failures (Selection in the process of designing), Standards, I.S. Codes, Preferred Series and Numbers **Design of Joints against static loads**: Cotter joint and Knuckle joint ,	**[10 hrs]**
Unit II Design of bolted and welded joints under axial and eccentric loading conditions. Design of power screw: Thread forms, multiple threaded screws, terminology of power screw, design of screw jack. Design of Cylinder & Pressure Vessels: Types of pressure vessel, stresses induced in pressure vessel, Lame's, Clavarino's and Bernie's equations. Design of cylindrical & spherical pressure vessels. Design of nut, bolt, gasket & covers for pressure vessel.	**[10 hrs]**
Unit III **Design of shaft** for power transmission, static and fatigue criteria for shaft design, ASME codes for shaft design, Design of keys. Design of rigid and flexible coupling.	**[10hrs]**
Unit IV: **Design against fluctuating loads:** variables stresses, reversed, repeated, fluctuating stresses. Fatigue failure: static and fatigue stress concentration factors, Endurance limit- estimation of endurance limit, Design for finite and infinite life, Soderberg and Goodman design criteria, Fatigue design under combined stresses. **Curved Beams:** Assumptions made in the analysis of curved beams, Design of curved beams, bending stresses in curved beams, such as crane hook, C-frame, etc.	**[8 hrs]**
Unit V: **Design of clutches and brakes:** Single and multiple plate clutch, constant wear and constant pressure theory for plate clutches, Internal and external shoe brakes and band brakes. Introduction to disc brakes and its design concepts. **Design of Springs:** Spring material, Helical compression & tension springs under static and variable loads, Leaf spring, Laminated Springs.	**[10hrs]**

Sr. No.	List of Tutorials
01	Numerical on Design against static loads: Cotter joint and Knuckle joint
02	Numerical on design of bolted and welded joints
03	Numerical on design of power screw
04	Numerical on design of Cylinder & Pressure Vessels
05	Numerical on design of shaft, keys and coupling
06	Numerical on design of coupling
07	Numerical on Design of clutches and brakes
08	Numerical on Design of springs under static and variable loads.

Assignment (Guidelines)

1. Design exercise in the form of design calculations with sketch and or drawings on following machine components
   a) Bolted and welded joints
   b) Design against fluctuating loads (finite and infinite life)
   c) Shaft and coupling design
   d) Screw Jack
2. Comparative study and analysis of disc brakes used in motorcycles of different makes (at least 4)

References:

Text Books Recommended:

1. Design of Machine Elements, B.D. Shiwalkar. Central Techno publications
2. Design of Machine Elements, V. B. Bhandari., McGraw Hill education.
3. Design of Machine Elements, Sharma & Purohit, PHI.
4. Design Data book, B.D. Shiwalkar, Central Techno publications.
5. Mechanical Engg. Design, Shigley J E, TMH.
6. Design Data Book, PSG.

Reference Books Recommended:

1. Mechanical Design Analysis, M. F. Spotts, Prentice-Hall.
2. Machine Component Design, Robert C. Juvinall, Kurt M. Marshele, Wiley.
3. Machine Design, Maleev& Hartman, CBS publishers.
4. Hand book of Machine Design, Shigley&Mischke, McGraw Hill.
5. Machine Design, Robert L.Norton, Pearson.
6. The Principles of Design, Nam P. Suh, McGraw Hill

RTM Nagpur University- Mechanical Engineering
5th Semester
Design of Machine Elements –(BEME503T)
Syllabus (Practical)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
B.Tech 5th Semester Mechanical	**Design of Machine Elements**	-	-	2	1	25	25	50

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Design Cotter joint / Knuckle joint / Turn buckle/ crane hook, C-frame
CO2	Design bolted and welded joints, power screw and Cylinder & Pressure Vessels
CO3	Design the shaft, coupling, clutches and brakes
CO4	Design the spring under static and variable loads

Sr. No.	Syllabus- Design of Machine Elements (Practical),5th Sem, Mechanical Engineering
01	Design of Cotter joint, Knuckle joint
02	Design of bolted joints under axial and eccentric loading conditions.
03	Design of welded joints under axial and eccentric loading conditions
04	Design of power screw
05	Design of Cylinder & Pressure Vessels.
06	Design of power transmission shafts.
07	Design of Couplings
08	Design of crane hook, C-frame
09	Design of clutches and brakes.
10	Design of springs under static and variable loads..
NOTE: **Design problems (at least 8 problems should be included in the Journal)**	

Suggested References:

1. Design Data book, B.D. Shiwalkar, Central Techno publications
2. Design Data Book, PSG
3. Design of Machine Elements, V.B.Bhandari, McGraw Hill.

RTM Nagpur University- Mechanical Engineering
5TH SEM-Industrial Economics & Management-BEME504T
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
B.Tech 5th Sem Mechanical	Industrial Economics & Management	3	-	-	03	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
01	This course is designed to familiarize the learners with important economic terminologies and key industrial concepts and to create awareness about functions of Industrial management and the concept of marketing and financial management.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Understand the concept of demand and supply and its relationship with the price
CO2	Relate various factors of production with reference to different economic sectors
CO3	Analyze the causes and effects of inflation and understand the market structure
CO4	Acquire knowledge of various functions of management and marketing management
CO5	Perceive the concept of financial management for the growth of business

SYLLABUS- Industrial Economics & Management-BEME504T	
Contents	No of hours
Unit I Industrial Economics: Law of demand, Demand analysis, Types of demand, Determinants of demand, Supply, Law of diminishing marginal utility, Elasticity of demand, Types of elasticity of demand. ,	08
Unit II Factors of production, Firm and Industry, Law of return, Cost concepts, Fixed variable, Average, Marginal and Total cost, Depreciation and methods for depreciation, direct and indirect taxes	08
Unit III Inflation, effect of inflation, Monetary and fiscal measures to control inflation, deflation, Market and market structures, Perfect competition, Monopoly, Monopolistic competition, Oligopoly, Concept & overview of share market, Effect of share market on economy, Share market terminologies	08
Unit IV Definition, nature and scope of management, functions of management, Meaning and concepts of Marketing management, Marketing Mix, Channels of distribution, Advertising and sales promotion.	08
Unit V Meaning, nature and scope of financial management , Brief outline of profit and loss account, balance sheet, Budgets and their importance, Types of budgets- Rigid and flexible budgets.	08

Books Recommended:

Text Books

1. Modern Economics, H. L. Ahuja, S.Chand Publishers
2. Modern Economic Theory, K. K. Dewett., S. Chand Publishers
3. Engineering Economics, D. N. Dwivedi, A. Dwivedi, Vikas Publishing House
4. Industrial Management I.K. Chopde, A.M. Sheikh
5. Business Organization and Management S.A. Sherlekar

RTM Nagpur University- Mechanical Engineering
5TH SEM- Organizational Behaviour and Entrepreneurship Development -BEME505T
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
B.Tech 5th Sem Mechanical	Organizational Behavior and Entrepreneurship Development	3	-	-	03	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
01	The objective of the course is to create awareness among learners about the various essential aspects of organizational behavior and to impart know how on entrepreneurship development.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Understand the concept and importance of organizational behaviour
CO2	Acquire the knowledge of interpersonal behaviour and transaction analysis
CO3	Know different traits and theories of personality
CO4	Acquire a know-how on entrepreneurship development and its ecosystem
CO5	Get the knowledge of various sources of finance

SYLLABUS- Organizational Behaviour and Entrepreneurship Development	
Contents	No of hours
Unit I Concept of organization behavior, Importance of organization behavior, Key elements of organization behavior, scope of organizational behaviour.	08
Unit II Nature and meaning of interpersonal behavior, concept of transaction analysis, benefits and uses of transaction analysis, Johari window model.	08
Unit III Definition and meaning of personality, importance of personality, theories of personality, personality traits.	08
Unit IV Concept of entrepreneurship, characteristics of an Entrepreneur, types of Entrepreneurship, Functions of Entrepreneurs, factors affecting the growth of entrepreneurship, Women entrepreneurship in India, Problems and challenges of women entrepreneurs, Government's support system to develop women entrepreneurship.	08
Unit V Sources of financing the enterprise, Concept of fixed and working capital, factors influencing the requirement of working capital, Concept of start-up and start-up echo system, Concept of product life cycle.	08

Books Recommended:

Text Books

1. Organizational behaviour by MN Mishra, published by S.Chand.
2. The human side of organization by Michale Drafke, published by Pearson education.
3. Management and Organizational behaviour by Laurie.J. Mullins, published by Pearson education.
4. Organizational behaviour by K. Aaswathappa, Published by Himalaya publications.
5. Entrepreneurial Development By, S. S. Khanka S. Chand & Co. Ltd. New Delhi, 1999.
6. Entrepreneurial Development. By, S.Anil Kumar. New Age International.
7. Small- Scale Industries and Entrepreneurship, By, Dr. Vasant Desai, Himalaya Publication.
8. Management of Entrepreneurship. By, N.V.R. Naidu, I.K. International Pvt Ltd.

RTM Nagpur University- Mechanical Engineering
5TH SEM-(Open Elective –I)
Automobile Engineering -I -BEME505T
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
B.Tech 5th Sem Mechanical	**Open Elective - I Automobile Engineering**	3	-	-	3	30	70	100	3

Sr. No.	Course Objective The objective of this course are–
1	To make the students conversant with fundamentals of automobile systems
2	To develop competencies in the performance analysis of vehicle.
3	To understand the emerging trends in electric vehicles, Hybrid vehicles and fuel cell vehicles
4	To make the students conversant with Automobile Safety Considerations Electrical Systems and Modern Developments in Automobiles.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Demonstrate the vehicle construction, chassis, fuel supply system, lubrication system and cooling system in automobile.
CO2	Illustrate the principle and working of Transmission system and clutch, gear box, rear axle drives, fluid flywheel, torque converter.
CO3	Identify the steering, suspension system and brake system.
CO4	Understand the applications of electrical/electronic system of automobile and wheels, tyres.
CO5	Explain the concept of electric vehicles, Hybrid vehicles, fuel cell vehicles and vehicle pollution norms. Appraise the automobile safety system and recent development in automobiles.

Syllabus- Automobile Engineering- Open Elective - I	
Contents	No of hours
Unit I: **Introduction:** Classification of automobiles, Major components and their functions. Chassis, different vehicle layouts. **Engine Power Plant:** Constructional features of different types of engines used in automobiles. Fuel supply systems, cooling systems, lubrication systems.	7
Unit II **Transmission system:** **Gear Box:** Necessity of transmission, principle, types of transmission, sliding mesh, constant mesh, synchromesh, transfer gear box, gear selector mechanism. Torque converter, semiautomatic and automatic transmission. Propeller shaft, universal joint, Hotchkiss drive, torque tube drive. Differential and its need. Rear axles and Front axles. **Clutch:** Necessity, requirements of a clutch system. Types of Clutches, centrifugal clutch, single and multi-plate clutch, fluid clutch.	8
Unit III **Steering systems:** Principle of steering, steering geometry and wheel alignment, Power Steering. Under steer, Over-steer. electronic power steering **Suspension systems:** Need, Function of spring and shock absorber, conventional suspension, Independent, suspension System, Active suspensions. **Brakes:** Function, Classification, Basic Components. Drum Brakes, Disc Brakes, Hydraulic brakes, Air Brakes, ABS.	8
Unit IV **Electrical Systems:** Battery, magneto and electronic ignition systems, horn, side indicator and wiper Automobile air-conditioning. Automotive Llighting circuit, Importance, types and specifications, LEDs, Reflectors. **Automotive Electronics:** Dashboard instrumentation, Sensors used in automobiles, ECU. **Wheels and Tyres:** Types of wheels, wheel dimensions, tyre, desirable tyre properties, types of tyres, comparison of radial and bias-ply tyres, factor affecting tyre life.	7

Unit V Electric vehicles, components of EV, EV Batteries, EV Chargers. Hybrid vehicles, types of hybrids and Fuel cell vehicles. Alternative energy sources, CNG, LPG, biodiesel, bio-ethanol, gasohol and hydrogen fuels in automobiles. **Vehicle Pollution Control:** cause and types of Emissions from Vehicle, Euro and Bharat Stage norms, Methods to reduce vehicular pollution, after treatment devices, EGR and Catalytic Converter. **Automobile Safety Considerations and Modern Developments in Automobiles:** Requirements of automobile body, Vehicle Safety Necessity, active and passive safety, Restrain Systems (seatbelts), Air Bags, crash worthiness. Recent advances in automobiles such as, collision avoidance, intelligent lighting, intelligent highway system, navigational aids, Automatic Cruise Control and Parking Assistance system.	8

References:

Text Books Recommended:

1. Automobile Engineering Vol. I & II, Kirpal Singh, Standard Publishers, Delhi
2. Automobile Engineering, R.K.Rajput, Luxmi Publications, New Delhi
3. Automobile Engineering R.B. Gupta, Satya Prashan, New Delhi
4. Course in Automobile Engineering, Sharma R. P, Dhanpat Rai and Sons, New Delhi, 1998.

Reference Books Recommended:

1. Automobile Mechanics, Crause, W.H., Tata McGraw Hill, New Del hi, 2007.
2. Vehicle and Engine Technology, Heinz Heisler, Arnold, London, 1999.
3. Automotive Engines, Srinivasan S., Tata McGraw Hill, New Delhi, 2001.

RTM Nagpur University- Mechanical Engineering
5th Sem- Open Elective-I
Project evaluation and Management –(BEME505T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
B.Tech 5th Sem Mechanical	Open Elective-I Project evaluation and Management	3	-	-	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	To develop an understanding towards a structured approach for every unique project undertaken in the industrial context about its need, concept, tools and techniques of project management approach
2	To develop working knowledge of the technical and financial aspects of project management decisions. Increase awareness and strengthen skills in applying participatory methods to project management.
3	Understand the project management lifecycle and be knowledgeable on the various phases from project initiation through closure.
4	Develop detailed project plan to include: Defining a project's scope and tasks, estimating task resource needs, assessing project risk and response strategies, a communications plan, and more.
5.	Understanding the critical role of an strong project manager played in project success.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Utilize the use of a structured approach for each and every unique project undertaken including utilizing project management concepts, tools, and techniques.
CO2	Apply participatory methods to project management.
CO3	Do network scheduling and network planning
CO4	Manage lifecycle on the various phases from project initiation through closure.
CO5	Do estimation of project Costs, Earned Value Analysis, Monitoring Project Progress, Project Appraisal.

Syllabus-Project evaluation and Management (Open Elective -I) 5th Sem ,Mechanical Engg	
Contents	No of hours
Unit I Definition & Characteristics of Project Performance Parameters: Time, Cost & Quality. Classification of Projects: Sector based, Investment based, Technology based, Cause based, Need based - Balancing, Modernization, Replacement, Expansion & Diversification. Project Life Cycle Phases – Concept/Initiation Phase: Parameters Involved in Project Identification. Sources of New Project Ideas. Governmental Framework for Identification of Opportunities, Incentives from state & central govt.; Import-substitution projects. ,	9
Unit II Project Conceptualization & Feasibility Analysis Project Definition Phase: Project Formulation & Feasibility. Types of Feasibility Studies – Pre-feasibility, Support/Functional Feasibility Study. Preparation of Project Feasibility Report & Specification; Aspects of Project Feasibility Managerial/Organization: Promoters Background, Criteria of Evaluation, Marketing/Commercial: Demand & Supply, Competition, Market Survey, Porter's 5 Forces, Operational/Technical: Process, Technology, Location, Capacity, Labour, Raw Material & Utility Availability. Financial: Cost of Project, Means of Finance, Financial Projections – Profit & Loss Account, Balance Sheet, Funds Flow Statement, Cash Flow Statement, Schedule of Fixed Assets, Schedule of Term Loans. Socio-Economic: Socio-Cost Benefit Analysis. Effective Rate of Protection, Domestic Resource Cost. ,	9
Unit III Project Planning- Development of Project Network; Project Representation; Consistency and Redundancy in Project Networks; Project Scheduling- Basic Scheduling with AO-A Networks; Basic Scheduling with A-O-N Networks; Project Scheduling with Probabilistic Activity Times. Planning & Organization Phase: Project Planning, Scheduling & Monitoring, Statement of Works, Project Specifications, Work Breakdown Structure, Network Analysis & Duration Estimating Network Diagrams – PERT/CPM, Estimate Activity Times, Milestone Scheduling. Resource Leveling, Resource Smoothening, Project Crashing. ,	9

Unit IV Project Cost Estimation: Need, Causes of Cost & Time Overruns. Nature of Cost Estimates, Types of Project Cost Estimates, Estimation of Manpower & Utilities. Project Budgeting & Control, Earned Value Management System: Concept of AC, PV, EV, Variances, etc. Contract Management: Responsibility Sharing Matrix, Types of Contract Payments, Risk Factors in Contracts – Contractor & Owner. Project Management Information System and Control, Management Pitfalls. ,	9
Unit V Project Implementation & Control Implementation Phase: Activities Involved: Erection & Commissioning, Installation, Trial Runs & Commencement of Commercial Production. Cleanup/Shutdown Phase: Handover to Client, Settlement of Accounts. Project Risk Management, Responsibility Sharing Matrix, Critical Chain Project Management – Critical Path vs Critical Chain, Concept of Buffers – Project buffer, resource buffer, feeding buffer. ,	9

Sr. No.	List of Tutorials
01	Writing an Exercise with Latest Software.(Ms Project) a complete project step by step on any one industry.

References:

Text Books Recommended:

1 Narendra Singh; Project Management & Control; Himalaya Publishing House, Mumbai
2 S. Choudary, Project Management, Tata McGraw Hill
3. Prasanna, C; Projects: Preparation, Appraisal, Budgeting & Implementation, Tata Mc-Graw Hill, New Delhi, (1987).
4 Chas R.B., Aqulino, N.J. and Jacob,F.R., Production and Operations Management: manufacturing and services, Tata McGraw Hill, New Delhi (1999).

Reference Books Recommended:

1. Maylor H, Project Management, Pearson Education Asia, New Delhi, (2009).
2. Cleland D , Project Management, Tata Mc-GrawHill, New Delhi, (2007).

RTM Nagpur University- Mechanical Engineering
5th Semester
Industrial Visit –(BEME506P)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
B.Tech 5th Sem Mechanical	**Industrial Visit**	-	-	2	1	50	--	--	1hr

Sr. No.	Course Objective The objective of this course is–
1	Industrial visits provide the students with an opportunity to learn practically through interaction, working methods and employment practices. It gives the students an exposure to current work practices as opposed to theoretical knowledge being taught at their college classrooms

Course Outcomes	
After the successful completion of this course the students are able to:	
CO1	Opportunity to interact with Industry Experts
CO2	Learning experience.
CO3	Enhanced employability and PPO's.
CO4	Interpersonal skills enhancement.
CO5	Day off from the usual melancholy.

Contents
A student pursuing a certain degree will be taken to companies or industries related to their field for a visit and there the students will be exposed briefly to the procedures, processes, work environment, management efforts taking place in that industry
Students should meet industry leaders, professionals, entrepreneurs, policymakers, and corporates who share their wisdom, learning, and experiences. Through these interactions students should develop leadership qualities, management skills, and learn about the industry working. Industry interaction can be helpful in updating the curriculum when there are significant changes in prevalent technologies; also, the faculty members get to know about the industry's latest trends.
Educational tours to industries provide an opportunity for students to see and experience real workstations, plants, machines, systems, assembly lines, and interact with highly trained and experienced personnel. Students should present a report on the industry he/she visits.
For students, such trips open many doors for corporate training and internships, which in turn increase the students' employability.
During the industrial visits, the students get an opportunity to experience how professionals live, learn about various management concepts like Just In Time or Lean manufacturing and how they are put into action. It is not easy to manage hundreds of skilled and unskilled workers at the same time and meet the stringent quality norms and production targets of the company. How managers, production engineers, employees work in tandem to achieve a common target is a management lesson in itself. Students are supposed to understand them.
Industrial trips help students to enhance their interpersonal, communication skills, and teamwork abilities. These visits have, time and again, proved to be an excellent platform for networking as the students interact and connect with the corporates via official social media platforms like Facebook, Linked In, and Twitter. These educational/ industrial trips also help the students identify their learning towards a branch and decide their future work areas like marketing, finance, operations, IT, HR, etc.

Checklist

For Teachers:

1. Have you given the student some background about the organization?
2. Have you clearly defined the learning objectives to the organization and the students?
3. Have you ensured the plan for the day with the students and the learning procedure including the timings?
4. Have you elaborated the risk assessments to the students and the safety procedure along with the behavior to be followed?
5. Have you ensured the permission from the Parents and the Guardians regarding the visit?
6. Prepared the students on the personal objectives?
7. Have you helped students form questions to be asked in the industry?
8. Have you introduced the students to the scientific topics that they will encounter on the visit?

Checklist for Students:

1. How conducive is the working environment
2. What type of organization is this?
3. Hierarchical structure in the organization
4. Products handled
5. Where is the workplace located?
6. How are the desks arranged?
7. Is it an open office or a closed office?
8. What is the noise level in this industry or factory?
9. What are the staff benefits?
10. Do the employees appear happy and engaged?
11. What are the age level and the gender balance?
12. What are the various departments and the varied availabilities?
13. Commutation mode to employees?

14. Are the employees challenged by their work?
15. What is the company culture followed?
16. The dress code maintained by the employees of both the genders?
17. Could you see yourself as a prospective employee of the company in the future?
18. Does this sector of education fascinate you?

Checklist for Organizing Team:

• Ensure that the college and the company are well aware of the Number of students', their age.
• Purpose of the visit is made clear to both the parties and MOU is signed by the company and the school to comply with the rules of the organizing team.
• Do you understand the learning outcomes for the students and have a clear idea of how the visit will meet these?
• Have you carried out a risk assessment and undertaken any other health and safety responsibilities
• Have you got a clear understanding of the plan for the day and the timings of activities?

NOTE

1. Students FEEDBACK form and Report must be collected and kept for reference during committee visits

2. A detailed report of all industries visited by the students must be prepared and kept for reference during committee visits

3. Minimum 70% of total teaching staff should have visited at least one company with students

RTM Nagpur University- Mechanical Engineering
5TH SEM-Performing Art (BEME507P)
Syllabus (Theory)- Mandatory Course

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
B.Tech . 5th Sem Mechanical	**Performing Art**	00	00	03	00	-	-	-	-

Sr. No.	Course Objective The objective of this course is–
1	A short course in art is at the heart of this course and is intended to open the way for students to "think outside the square" – or more precisely, through art to find themselves in that challenging but potentially wonderful place outside their own personal square.

Course Outcomes

An Arts and Science course helps the students to empower themselves with problem solving skills. The ability to analyze things and communicate them in the right way is taught. These skills are very much essential to get employed in reputed companies and most of the companies prefer candidates with the mentioned skills. The students also have a variety of career options to choose for the future

Performing Art –Suggested Activities. However Institutes are free to design their own course as per their convenience

LEVEL -1

Music	Dance	Drama
1. Raga studies	1. History of Dance	1. Acting
2. Western music	2. Choreography	2. Basic vocal practice
3. Hindustani music	3. New media	3. Communication skills
4. Study of Tala	4. Performance Practice	4. Yoga
5. Shastra	5. Indian Culture	5. Direction
6. Rabindra sangeet	6. Techniques of Dance	6. Event management
7. Folk music	7. Movement Techniques	7. Computer skills
8. World music	8. Dance on Camera	8. Indian theatre
		9. History of theatre
		10. Western theatre
		11. Camera, light, sound
		12. Filming concepts
		13. Projects on short films
		14. TV production
		15. Film Theories

LEVEL -2

Music	Dance	Drama
1. Analytical study of raga 2. Raga classification system 3. Indian aesthetics 4. Comparative aesthetics 5. A critical study of specified raga 6. Composition forms of Indian vocal music	1. History of dance 2. Dance and sculpture 3. Kathak 4. Bharatnatyam 5. Rasa & Nayak Nayika Bheda 6. Traditional folk dance 7. Dance and Sanskrit treaties	1. Theatre game & physical exercises 2. Voice speech 3. Acting on stage 4. Play production 5. Classical Indian theatre 6. Direction zones 7. Stage management 8. Acting on camera 9. TV and film production 10. Children's theatre 11. Folk performances 12. Play production 13. Improvisation, Mime and choreography

RTM Nagpur University-Mechanical Engineering
B.Tech 6th Semester
Automation in Production (BTME601T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
B.Tech 6th Sem Mechanical	**AUTOMATION IN PRODUCTION**	3	-	-	3	30	70	100	3Hrs

Sr. No.	Course Objective The objective of this course is–
1	To develop the ability to analyze any engineering problem and apply logic for getting solution so as to develop decision making skill in current manufacturing environment
2	To get the understanding regarding how automation is used to increase production
3	To develop ability to understand latest automation in production like CNC, Robotics etc.
4	To develop understanding of various techniques like FMS,CAPP and CAD/CAM

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Get Acquainted With Automation, Its Type‘s ,Strategies , Assembly Line Balancing And Its Analysis, Methods Of Work Part Transport
CO2	Recognize fundamentals and constructional features of N.C, CNC and D.N.C machines and prepare a CNC program for given part.
CO3	Get Acquainted With The Robotic Configuration, Types Of Links, Joints, Grippers, Industrial Robotics And Robot Applications.
CO4	Cultivate Information About Automated Material Handling Systems, Automated Storage And Retrieval System (AGVS,AS/RS) Its Analysis
CO5	Get Acquainted With Automated Inspection (CAPP, CAQC, CMM) And Group Technology.
CO6	Recognize CAD/CAM,CIM,FMS, Understand The Concepts Of Shop Floor Control

SYLLABUS- **Automation In Production (BTME601T)**	
Contents	No of hours
Unit I Automation Automation -Definition, types, reasons, strategies for automating, arguments for and against automation. Production system, Difference between Mechanization and automation, USA principle, automation migration strategy, Automated Flow Lines- Methods of work part transport, Buffer storage. Analysis of flow lines and of transfer lines without storage, manual assembly lines. Line Balancing Problem, Methods of line balancing. (Largest Candidate Rule & RPW only)	9 Hrs
Unit II Numerical Control Production Systems and Industrial Robotics Numerical Control Production Systems- Basic concepts, coordinate system and machine motion- Types of NC systems- Point to point, straight cut and continuous path. Machine control unit and other components, .NC part programming, NC words, methods of part programming, manual part programming: APT programming, Direct numerical control. Computer numerical control. Adaptive control. Applications and economics of NC.(only APT programming should be asked in theory and manual programming in practical performance) Industrial Robotics - Introduction, robot anatomy, robot control systems, accuracy and repeatability and other specifications, end effectors,. Robot applications- ,	9Hrs
Unit III Automated material handling & storage: Automated material handling & storage-Conveyor systems : Automated Guided Vehicle Systems -Types: - Driverless trains, AGVS pallet trucks, AGVS unit-load carriers. Vehicle guidance & Routing, Traffic control & safety, System management, Analysis of AGVS systems, AGVS applications. Automated Storage & Retrieval System -Types :- Unit load AS/RS , mini load AS/I{S , man on board AS/RS , automated item retrieval system, deep lane AS/RS -Basic components & special features of AS/RS , Carousel storage systems , Work in process storage, (quantitative analysis is expected for AGVS,AS/RS and Carousel storage systems). ,	9Hrs
Unit IV Automated inspection & Group technology: Automated inspection methods -100% automated inspection, off-line & on -line inspection, distributed inspection & final inspection; coordinate. measuring Machine Construction, operation & benefits, Machine vision image acquisition & digitization, image processing & analysis, interpretation and applications; Group Technology: Part families, parts classification & coding, Opitz classification systems production. production. Flow analysis; Machine cell design -composite pat concept, types of cell design, benefits of group technology. ,	9Hrs

Unit V **Computer aided manufacturing** - Manufacturing planning, manufacturing control; Computer integrated manufacturing. **Flexible manufacturing systems** - Components, Types of systems, FMS layout configuration computer functions, data files, system reports, FMS benefits. **Computer aided process planning** - Retrieval CAPP systems, generative CAPP systems, benefits of CAPP. **Introduction to PLC Programming,** Types of PLC Languages, Ladder Diagram Format, Ladder Relay Instructions, Ladder Relay Programming ,	9Hrs

Sr. No.	List of Tutorials
01	Numerical‘s on Automated Flow lines
02	Line Balancing Problem (Largest Candidate Rule & RPW only)
03	APT Program on 3 different geometries
04	Numericals on AGVS,AS/RS and carousel storage System
05	Minimum Two tutorial in form of Quiz on Online platform like Moodle
06	Any other if required

References:

Text Books Recommended:

1. Automation, production System & CIMS Third edition (2007) M P, Groover PHI Prentice Hall
2 CAD/CAM Fifth edition (2008) Zimmers & Groover PIll Pearson Education India
3. Joffrey Boothroyd, Peter Dewhurst and Winston A. Knight, ―Product Design for manufacture and Assembly‖, CRC Press
4 Deb S.R., ‗Robotics‖, Tata McGraw Hill Publications, New Delhi.
5 Yoram Koren, ; Robotics for Engineers;, McGraw Hill Book Co.
6 John W Webb and Reis, Ronald A., "Programmable Logic Controllers: Principles & Applications‖,Prentice Hall.
6.Frank Petruzella," Programmable Logic Controllers", McGraw-Hill Education; 4 edition
7.K. Kundra, P.N. Rao, N.K.Tiwari ‗Numerical Control and Computer Aided Manufacturing‖ ,Tata McGraw Hill
8.Krar, S., and Gill ―CNC Technology and Programming‖, , A., McGraw Hill publishers

Reference Books Recommended:

1. Numerical Control And Computer Aided Manufacturing 13th edition (2007)Rao, N K Tiwari, T K Kundra Tata McGraw-Hill Education
2 Computer Control of Manufacturing Systems 2005 Koren Mcgraw Hill

RTM Nagpur University-Mechanical Engineering
B.Tech 6th Semester
Automation In Production (BTME601P)
Syllabus (Theory)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
B.Tech 6th Sem Mechanical	**AUTOMATION IN PRODUCTION LAB**	-	-	2	1	25	25	50

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Recognize automation, corroborating this knowledge with case studies on automation systems. study and analyze the material handling systems, robots and GT
CO2	Demonstrate NC programming (manual/apt)
CO3	Simulate program on CNC milling/ lathe
CO4	Work on CNC milling/ lathe

Sr. No.	**Automation In Production (BEME601P) Syllabus (Practical)**
01	Practice Programming on Manual Part Program
02	Simulation on CNC lathe (at least two Complex Geometric) {May be performed in group}
03	Simulation on CNC milling (at least two Complex Geometries) {May be performed in group}
04	Performance on CNC lathe (at least two Complex Geometric) {May be performed in group}
05	Performance on CNC milling (at least two Complex Geometries) {May be performed in group}
06	Performance/ Study Practical on Robot.
07	Part Coding and Group Technology
08	Study of FMS
09	Study of Automated inspection

Suggested References:

1. Automation, production System & CIMS Third edition (2007) M P, Groover PHI Prentice Hall

2..K. Kundra, P.N. Rao, N.K.Tiwari –Numerical Control and Computer Aided Manufacturing‖ ,Tata McGraw Hill

3. Deb S.R., –Robotics‖, Tata McGraw Hill Publications, New Delhi.

RTM Nagpur University-Mechanical Engineering
B.Tech 6th Semester
Energy Conversion-II (BTME602T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examina	Total	
B.Tech 6th Sem Mechanical	**Energy Conversion-II**	3	-	-	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1.	To give an overview of energy conversion system their type, applications, operation , testing methods
2.	To carry out thermodynamic analysis of various cycles of operation
3.	To gain basic knowledge of operation of IC Engine , gas turbine , jet propulsions, compressor , refrigeration and air conditioning system
4.	To Identify and understand the function of various components of IC Engine gas turbine , compressor, refrigeration and Air condition system.

Course Outcomes

After successful completion of this course the student will be able to:

CO1	Classify various types of I.C. Engines and explain the working of its various components and systems.
CO2	Analyze the effect of various operating variables on engine performance
CO3	Understand the working of Gas Turbine and Jet propulsion system
CO4	Analyze the vapour compression refrigeration system and psychometric process.
CO5	Understand the working of various types of compressors

Syllabus -Energy Conversion-II (Theory), 6th Semester , Mechanical Engineering	
Contents	**No of hours**
Unit I Internal Combustion Engines: Introduction, classification, components of I.C. Engines, working of two stroke and four stroke S.I. and C.I. Engines, valve and port timing diagram, Combustion in S. I. Engine, stages of combustion, ignition lag, detonation. Combustion in C. I. Engine, stages of combustion, delay period, diesel knock, abnormal combustion in S.I. and C.I. engines, detonation and knocking. Fuel injection in I. C. Engines: Fuel supply to S. I. Engine, carburetion, simple carburetor, components, operation, MPFI. Fuel supply to C. I. Engine, Fuel pump amd fuel injector,Modern Ignition System for S.I. Engines, Supercharging of SI and CI engines, Introduction to Electric and Hybrid Vehicles	08
Unit II Testing of I. C. Engines:- Performance parameters, measurement of indicated, friction & brake power, measurement of speed, fuel & air consumption, calculation of indicated & brake thermal efficiency, volumetric efficiency, relative efficiency and mechanical efficiency, percentage of excess air, Heat balance sheet, exhaust gas calorimeter, exhaust analysis, performance characteristics, factors influencing the performance of I.C. engines,	07
Unit III **Gas Turbines**:-Ideal cycles isentropic and small stage efficiency, application of gas turbine pressure losses, effect of intercooling, reheat & regeneration, fuel-air ratio, combustion efficiency, performance calculation, open cycle &closed cycle gas turbine plants cogenerations & combined power cycles , Axial Flow Turbines. **Jet Propulsion**: Simple turbojet cycle, Tuboprop, Ramjet & pulse jet, performance parameters like thrust power, propulsive power. Thermal efficiency, propulsive efficiency, overall efficiency, Chemical Rockets, types of propellants and their properties, cryogenic propellant, combustion phenomena, ignition and inhibitors. Basics of Electrical and Nuclear rockets	07
Unit IV **Refrigeration**: Introduction, definition & unit of refrigeration, COP ,single stage vapour compression refrigeration system, effect of subcooling and superheating on COP with P-h and T-S diagram, Vapor absorption refrigeration system (concept only), refrigerants, Ozone depletion. **Air conditioning**: Introduction, psychometric properties, psychometric processes such as heating cooling, humidification & dehumidification, Bypass factor, Split air conditioner, Inverter Air conditioner.	09

Unit V **Air Compressors**:- Introduction, classification, applications ,Positive displacement Compressors:- **Reciprocating compressors**: - Construction and working, isothermal, polytropic & adiabatic compression process, work done with and without clearance, P-V diagram, volumetric efficiency, effect of clearance, isothermal efficiency, methods for improving isothermal efficiency, mechanical efficiency. Multistage compression. **Rotary compressors**: Principle, operation, Roots blower , vane type , screw type , lobe type indicator diagram, work done, roots efficiency, vanes efficiency. **Centrifugal compressor**: - Principle, operation, parts, velocity diagrams, static & total head quantities, work done by impeller, isentropic efficiency, **Axial flow compressor**:- Principle, operation, parts, velocity diagrams, work done, degree of reaction, stage and polytropic efficiency.	10

List of Tutorials- Energy Conversion-II

1) Analysis of single stage reciprocating compressors.
2) Analysis of multistage reciprocating compressors.
3) Analysis of effect of undercooling and superheating on COP of VCR system.
4) Performance analysis of centrifugal compressor.
5) Performance analysis of axial flow compressor.
6) Numerical on Morse test.
7) Analysis of multi-cylinder engines.
8) Numerical on heat balance sheet.
9) Analysis of gas turbine cycle.
10) Analysis of Jet propulsion system.
11) Analysis of Air Conditioning systems.

References- Energy Conversion-II

Text Books Recommended:

1. Basic and Applied Thermodynamics, P.K. Nag, TMH publication
2. Thermal Engineering, R. K. Rajput, Laxmi publications.
3. Refrigeration and Air Conditioning, Arora and Domkundwar, Dhanpat Rai and Sons.
4. Gas Turbine& Jet Propulsion, Dubey & Khajuriya, Dhanpat Rai & Sons
5. Internal Combustion Engine –V Ganesan , Tata McGraw Hill

Reference Books Recommended:

1.Thermal Engineering, Mathur & Mehtra, Jain Brothers Publications, New Delhi
2. Refrigeration & Air conditioning, Stocker & Jones, McGraw Hill Publication.
3.Elements of Gas Turbine Propulsion, Jack D. Mattingly McGraw-Hill, Inc., 1996.
4. Internal combustion engine fundamentals, by: John Heywood, pub.: McGraw- Hill .
5. N.A.Cumpsty, Jet Propulsion, Cambridge University Press, 2000

RTM Nagpur University-Mechanical Engineering
B.Tech 6th Semester
Energy Conversion-II (BTME602P)
Syllabus (Practical)

Semester	Course Title	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
B.Tech 6th Sem Mechanical	**Energy Conversion-II Lab**	-	-	2	1	25	25	50

Sr. No.	Course Objective The objective of this course is–
1.	To provide knowledge of how energy can be converted from one form to another.
2.	Students will observe the loss in useful energy as a result of such a conversion and measure the efficiency for such conversions.
3.	To make students familiar with the design and operating characteristics of engines. ¬
4.	To understand the basic concept of refrigeration and air conditioning.

Course Outcomes

After successful completion of this course the student will be able to:

CO1	**Identify** different components of IC engine, type of compressor , VCR system
CO2	**Demonstrate** and **Determine** performance of I,C, engine ,compressor and VCR system
CO3	**Construct** Heat balance sheet for single/multi cylinder CI and SI engine.
CO4	**Apply** Mores Test on Multi cylinder S.I. Engine
CO5	**Analyze** the thermodynamic performance of Gas turbine
CO6	Develop an ability to optimize future engine designs for specific sets of constraints (fuel economy, performance, emissions)

Sr. No.	List of Practical
01	Performance testing of two stroke / Four stroke Multi cylinder Diesel and Petrol engine
02	Performance testing of variable compression ratio engine
03	Morse test on Multi cylinder Diesel/ Petrol engine
04	Creating heat Balance Sheet for Diesel Engine and petrol engine
05	Demonstration of fuel injection systems and ignition systems of I. C. Engines.
06	Valve Timing diagram for petrol engine
07	Performance testing of multi stage Reciprocating compressor
08	Performance testing of Centrifugal and Axial flow Compressor
09	To study open cycle constant pressure combustion gas turbine with inter cooler, regenerator and reheater.
10	Demonstration to study Psychometric Processes on mini-air conditioning tutor.
11	Performance testing of vapour compression refrigeration system
12	Performance testing of vapour absorption refrigeration system.

References- Energy Conversion-II

Text Books Recommended:

1. Basic and Applied Thermodynamics, P.K. Nag, TMH publication
2. Thermal Engineering, R. K. Rajput, Laxmi publications.
3. Refrigeration and Air Conditioning, Arora and Domkundwar, Dhanpat Rai and Sons.
4. Gas Turbine& Jet Propulsion, Dubey & Khajuriya, Dhanpat Rai & Sons
5. Internal Combustion Engine –V Ganesan , Tata McGraw Hill

Reference Books Recommended:

1.Thermal Engineering, Mathur & Mehtra, Jain Brothers Publications, New Delhi
2. Refrigeration & Air conditioning, Stocker & Jones, McGraw Hill Publication.
3.Elements of Gas Turbine Propulsion, Jack D. Mattingly McGraw-Hill, Inc., 1996.
4. Internal combustion engine fundamentals, by: John Heywood, pub.: McGraw- Hill .
5. N.A.Cumpsty, Jet Propulsion, Cambridge University Press, 2000

RTM Nagpur University- Mechanical Engineering
B.Tech 6th Semester
Dynamics of Machines (BTME603T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examinatio	Total	
B.Tech 6th Sem Mechanical	**Dynamics of Machines**	3	-	-	03	30	70	100	3

Sr. No.	Course Objective The objective of this course is
1.	Make students understand the concepts of dynamics of the machines, effect of dynamic forces involved in various machine components, unbalances in the system due to these forces causing vibration and vibration control techniques.
2	To introduce them with the dynamics of rotating and energy absorbing components like gyroscopes, dynamometers, brakes and flywheels
Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Comprehend the machine dynamics through basic principles to interpret their application and examine near to life problems due gyroscopic effects and determine the conditions for stability of ships, airplanes and automobile.
CO2	Analyze dynamic force conditions in planer linkages and cams to determine required driving torque condition (graphically/ analytically).
CO3	Estimate the unbalanced forces due to rotating and reciprocating masses in a mechanical system and calculate (graphically/ analytically) the balancing masses required for safe/ smooth operation of these mechanical systems.
CO4	Identify the requirement of flywheel, brakes, and dynamometers in a mechanical system and calculate inertia of flywheel and braking condition to be incorporated in engines and machines.
CO5	Recognize and interpret the concept of vibration in various mechanical systems and distinguish vibration characteristics for 1 & 2 DOF systems to evaluate the conditions for its control/ use.

Syllabus- Dynamics of Machines(Theory,) 6th Semester , Mechanical Engineering	
Contents	No of hours
Unit I – Gyroscopic Effect: Introduction, precession motion, Effect of gyroscopic couple on shaft bearings, airplane, naval ship, vehicle stability. Introduction to electronic gyroscopes and its applications in the modern automobiles.	9
Unit II - Dynamic force analysis: Concepts in machine element dynamics. D'Alembert principle. Application of these approaches for equilibrium of mechanisms, Static and Dynamic force analysis of planar linkages such as four bar chain and reciprocating mechanism by graphical method, Analytical method. Cam dynamics and jump-off phenomenon.	9
Unit III - Balancing **Balancing of rotating masses:** in one and several planes, static and dynamic balancing machines. [Graphical and analytical treatment] **Balancing of reciprocating masses:** in single and multi-cylinder engines, inline, radial and V type. Primary and secondary balancing analysis. Concept of direct and reverse crank. [Graphical and analytical treatment]	9
Unit IV- Brakes and Dynamometer – Types of brakes, block brake, band brake, internal expanding brake and effect of braking on vehicle, types of dynamometer, absorption and transmission dynamometer, chassis dynamometer, eddy current dynamometer. [Analytical treatment for Brakes] **Flywheel** - Turning moment Vs crank angle diagram for single- cylinder and multiple-cylinder engines, flywheel application in punching machines. [Analytical treatment]	9
Unit V - Vibration Analysis: Types of vibration, degree of freedom, method of vibration analysis of un-damped and damped free & forced vibration system. Types of damping, Logarithmic decrement, magnification factor, vibration isolation and transmissibility. Whirling of shaft and critical speed of rotors. Torsional oscillation of two-disc and three disc rotors, torsional vibration of a geared system.	9

Sr. No.	List of Tutorials - Dynamics of Machines, 6th Semester , Mechanical Engineering
01	Problems on airplanes, ships and other vehicles stabilization
02	Problems on cam dynamics
03	Problems on static and dynamic balancing of rotating masses
04	Problems on firing order in multi cylinder and its effect on balancing of engines
05	Problems on different types of brakes and flywheels
06	Problems on free, damped and undamped vibrations. One problem each on forced vibrations and torsional vibrations.

Assignments (Optional-To be decided by individual faculty):

1. Preparations of computer algorithm using analytical method for dynamic force analysis using MS excel spread sheets.
2. Study and analysis of brakes used in various Motorcycle models available in Indian market at least four models of equal engine cc.
3. Study and analysis of shock absorbers used in various Motorcycle models available in Indian market at least four models of equal engine cc.

References:

Text Books Recommended:

1. Theory of Machines, Rattan S. S, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
2. Mechanism & Machine Theory, A.G. Ambekar, PHI Publication.
4. Mechanical Vibrations, V. P. Singh, Dhanpatrai & Co.

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Reference Books Recommended:

1. Theory of Mechanisms and Machines, Ghosh A. and Mallick A.K., Affiliated EastWest Press Pvt. Ltd., New Delhi, 1988.
2. Theory of Machines and Mechanisms, Shigley J.E. and Uicker J.J.,McGraw-Hill, Inc., 1995.
3. Mechanism and Machine Theory, Rao J.S. and Dukkipati R.V., Wiley-Eastern Limited, New Delhi, 1992
4. –Theory of Machines, Sadhu Singh, Pearson Education.
5. –Mechanical Vibrations‖, S. S. Rao, Addison-Wesley Longman

RTM Nagpur University- Mechanical Engineering
B.Tech 6th Semester
Dynamics of Machines Lab (BTME603P)
Syllabus (Practical)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
						Continual Assessment	University Examination	Total
		L	T	P				
B.Tech 6th Sem Mechanical	Dynamics of Machines Lab	-	-	2	1	25	25	50

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Demonstrate the concept of gyroscopic effect through the working model.
CO2	Analyze the performance of mechanisms and Perform dynamic force analysis of linkages and cams.
CO3	Demonstrate record and interpret data of vibration characteristics of mechanical vibratory systems.
CO4	Perform analysis of brakes, dynamometers and flywheels.
CO5	Identify the importance of safety, team work and effective communication for conduction of activity.

	Syllabus- Dynamics of Machines (Practical) 6th Semester , Mechanical Engineering
Sr. No.	**List of Practical (Have to perform at least eight practical's)**
01	Dynamic balancing of rotating masses (study of wheel balancing machine along with performance by visiting any automobile workshop).
02	Determination of jump speed of a cam follower mechanism
03	Critical speed of shafts.
04	Performance characteristics of Gyroscope.
05	Determination of natural frequency of Free longitudinal vibration of single DOF system
06	Torsional vibration of single and two rotor system.
07	Dynamic force analysis of four bar mechanisms OR Dynamic force analysis of slider crank mechanism.
08	Performance analysis of quick return motion mechanism in a machine tool in college workshop
09	Performance on flywheel of an engine in IC engine laboratory.
10	Performance of dynamometer in IC engine lab
11	Determination of braking efficiency of two wheeled vehicle

References:

Text Books Recommended:

1. Theory of Machines, Rattan S. S, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
2. Mechanism & Machine Theory, A.G. Ambekar, PHI Publication.
4. Mechanical Vibrations, V. P. Singh, Dhanpatrai & Co.

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Reference Books Recommended:

1. Theory of Mechanisms and Machines, Ghosh A. and Mallick A.K., Affiliated EastWest Press Pvt. Ltd., New Delhi, 1988.
2. Theory of Machines and Mechanisms, Shigley J.E. and Uicker J.J.,McGraw-Hill, Inc., 1995.
3. Mechanism and Machine Theory, Rao J.S. and Dukkipati R.V., Wiley-Eastern Limited, New Delhi, 1992
4. –Theory of Machines, Sadhu Singh, Pearson Education.
5. –Mechanical Vibrations‖, S. S. Rao, Addison-Wesley Longman

RTM Nagpur University-Mechanical Engineering
B.Tech 6th Sem-(Elective-I)
Operation Research(BTME604T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
B.Tech 6th Sem Mechanical	Operation Research (Elective-I)	03	-	-	03	30	70	100	03

Sr. No.	Course Objective The objective of this course is–
1	To study the various OR tools,
2	Study to apply appropriate model to the given situation.
3	Formulate the problem.
4	Solve and analyze the problem

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Recognize the importance and value of Operations Research and mathematical modeling in solving practical problems in industry
CO2	convert given situation to mathematical form and determine optimal settings.
CO3	understand Operations Research models and apply them to real-life problems;
CO4	manage projects for minimum total cost and smooth level of resources.
CO5	make decisions related to age of replacement of equipment
CO6	develop simulation of real life system to analyze and optimize system concerned.

Syllabus -Operation Research(BTME604T)-6th Sem-(Elective-I)	
Contents	No of hours
Unit I Introduction to OR & Basic OR Models, Definition Characteristics and limitations of OR.Linear programming: Introduction, Linear programming formulation, solutions of LPP by graphical methods and simplex method. formulation of Dual of LPP.	08 Hrs
Unit II Formulation of transportation model, Basic feasible solution using different methods (North-West corner, Least Cost, Vogel's Approximation Method) Optimality Methods, Unbalanced transportation problem, Variants in Transportation Problems. Formulation of the Assignment problem, unbalanced assignment problem, typical assignment & travelling salesman problem	08 Hrs
Unit III Replacement Models- Concept of equivalence, Interest Rate, Present worth, economic evaluations of Alternatives, Group replacement models. Inventory Control Models- Introduction and inventory management concepts, Economic Order Quantity model (EOQ), Economic Production Quantity model (EPQ), model for purchase allowing for shortages,ABC analysis.	08 Hrs
Unit IV Drawing of Network, CPM & PERT, probability of completion of project, Cost Analysis of Project, and Concept of Crashing. Allocation & updating of Network.	08 Hrs
Unit V Sequencing Model – Introduction, Sequencing Model: n job two machines problem, n job 3 machines problem, 2 jobs m machine problem. Simulations –Concept, applications in waiting line situations, inventory and network. Queuing models – Poisson arrivals and Exponential service times – Single channel models (MM1)and Multi channel models. (No derivation expected)	08Hrs

References:

Text Books Recommended:

1. 1. Operation Research, Heera & Gupta, S Chand Publications
2. Operation Research, JK Sharma, Mc Millian Publications

Reference Books Recommended:

1. Operation Research, Hamdy Taha, Prentice Hall
2. Operation Research, Liberman, McGraw Hill Publications
3. Operation Research , S D Sharma, Kedarnath Ramnath & Co.
4. Operations Research , Pannerselvam: Prentice Hall of India 2010

RTM Nagpur University-Mechanical Engineering
B.Tech 6th Sem- (Elective-I)
Production Planning and Control-(BTME604T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
						Continual Assessment	University Examination	Total	
B.Tech 6th Sem Mechanical	Production Planning and Control (Elective-I)	L	T	P	3	30	70	100	3 hrs
		3	-	-					

Sr. No.	Course Objective The objective of this course is–
1	Understand need of various functions in production planning and control for better management of manufacturing and/or service systems.
2	Use qualitative and quantitative forecasting techniques for short, medium, and long range forecasting.
3	Develop material requirements plans (MRP) as part of resource requirements planning systems.
4	Develop capacity requirements plans as part of resource requirements planning systems.
Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Understand need of various functions in production planning and control for better management of manufacturing and/or service systems.
CO2	Use qualitative and quantitative forecasting techniques for short, medium, and long range forecasting.
CO3	Develop material requirements plans (MRP) as part of resource requirements planning systems.
CO4	Use heuristic decision rules to make lot-sizing decisions.
CO5	Develop capacity requirements plans as part of resource requirements planning systems.
CO6	Develop quantitative models to manage independent demand inventory systems.

SYLLABUS -Production Planning and Control -(Elective-I)-6TH Sem	
Contents	No of hours
Unit I Production Planning : Introduction, Production Planning and Production Control, Functions and Objectives of PPC, Production procedure, Information requirement of PPC, Manufacturing Methods and PPC, Product Life Cycle, Product design.	8
Unit II Demand Forecasting : Forecasting and Prediction, Long-term and short-term forecasting, Time series analysis, least square method, exponential smoothing method, Moving Average forecasting.	7
Unit III Capacity And Process Planning : Introduction, Measurement and measures of capacity, factors influencing effective capacity, factors favouring over capacity and under capacity, aggregate planning, linear programming approach to aggregate planning, Master Production Schedule,Process Planning –Machine, Manpower Planning, line balancing. ,	8
Unit IV Inventory Control : Introduction, Types of inventories, reasons for keeping inventories, inventory control, benefits of inventory control, cost associated with inventory, inventory cost relationships, safety stock, inventory models, deterministic models. Material Requirement planning (MRP) **:** Stochastic models, inventory control system. Introduction, Objectives of MRP, MRP-I System, MRP-II system, Lot sizing consideration	8
Unit V Production Control : Introduction, loading, sequencing, priority sequencing, scheduling, dispatching and progressing.	7

Sr. No.	**List of Tutorials**
01	Tutorial on production processes, manufacturing method, product life cycle
02	Long term and short term for casting, time series analysis
03	Measurements and measures of capacity
04	Inventory control, types of inventory
05	MRP1 AND MRP2
06	Loading, sequencing, dispatching

References:

Text Books Recommended:

1. Martand Telsang, –Industrial Engineering and Production Management‖, S. Chand, New Delhi (2009)

2.Buffa, –Modern Production operations Management‖, Wiley Eastern, New York (1999)

3. Panneer Selvan R, –Production and Operations Management‖, Prentice Hall India, New Delhi (2002)

RTM Nagpur University-Mechanical Engineering
B.Tech 6th Sem- (Elective-I)
Tool Design-(BTME604T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
B.Tech 6th Sem Mechanical	Tool Design (Elective-I)	3	-	-	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	To impart knowledge of design and selection of tools used various manufacturing processes like single point cutting tools, multipoint cutting tool, press working cutting operation die-punch, press working forming operation die-punch, forgings process tools, jigs and fixtures.

Course Outcomes	
After the successful completion of this course the students are able to:	
CO1	Design single point and multi-point cutting tools.
CO2	Design various press working cutting operation dies for given sheet metal parts, also will be able to suggest heat treatment cycle for these dies.
CO3	Understand terminologies and design considerations related to press working bending, forming and drawing dies.
CO4	Explain and classify various forging dies and design machine forging dies.
CO5	Design simple blow and injection molds for plastic parts.

Syllabus - Tool Design (Elective II), 6th Sem, Mechanical Engineering	
Contents	No of hours
Unit-I:Design of single point and multi-point cutting tools **Design of single Point Cutting Tool:** Form tools- Introduction, Types, design of form tools. **Design of multipoint cutting tools:** Drills- Introduction, Types, Geometry, Design of drill, Milling cutters - Introduction, Types, Geometry, and Design of milling cutters.	**[9 Hrs.]**
Unit-II: Design of Press working Cutting operation dies **Press working (Cutting operation dies):** Introduction, Press working operations, construction and working of metal cutting dies e.g. simple die, compound die, progressive die, combination die. Design of heat treatment cycle for press tools Principle of metal cutting, press tonnage capacity, cutting forces, method of reducing cutting forces. **Blanking & Piercing die design –** Simple, compound & progressive dies.	**[9 Hrs.]**
Unit-III: Design of Press working forming operation dies **Bending:** Bending terminology, types of bending operation, blank development, spring back and its prevention, bending force and design of bending dies. Forming: Introduction, types of forming dies - Solid form dies, pad type form dies, curling dies, embossing dies, coining dies and its design. **Drawing:** Metal flow in drawing operation, factors affecting metal flow, calculation of number of draws, development of blank, drawing force, blank holding force and design of various types of drawing dies i.e. single action draw die, double action draw die and inverted dies.	**[9 Hrs.]**
Unit-IV: Forging die design and Design of molds : Introduction, Classification of forging dies, Single impression dies, Multiple Impression dies and Forging design factors. Preliminary forging operation - fullering, edging, bending, drawing, flattering, blacking finishing, cutoff. Die design for machine forging in closed & open die forging, materials of forging dies . **Mould Design:** Design of Simple Blow Moulds for Articles such as bottles, cans Design of simple two plate injection moulds , Mould Materials.	**[9 Hrs.]**
Unit-V: Design of Jigs and Fixtures: Introduction, general principles for design of jigs and fixtures, principle of location, principle for clamping, clamping devices, types of jig bushes, material and heat treatment, design of drill jig. Design of Milling Fixtures and lathe fixtures.	**[9 Hrs.]**

References:

Text Books Recommended:

1. Production Engineering ,P.C. Sharma, S. Chand Publication
2. Tool Design, Donaldson, Tata McGraw Hill, New Delhi
3. Jigs and Fixtures, P.H.Joshi, Tata McGraw Hill, New Delhi.

Reference Books Recommended:

RTM Nagpur University Mechanical Engineering
B.Tech. 6th Semester (Elective-I)
Renewable Energy Sources BTME(604T)
Syllabus- Theory

Semester	Course Title(Subject)	Hours /Week			Credits	Maximum Marks			ExamDuration (Hrs.)
		L	T	P		Continual Assessment	University Examine	Total	
VI	Renewable Energy Resources	3	-	-	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1.	To make the students conversant with the non-conventional energy resources, its need, and their utilization to harness the power.
2.	The students will learn the solar energy utilization with its applications.
3.	The students will understand the various methods by which energy can be generated from wind, ocean tides, Fuel Cell, Geothermal phenomenon, Biogas and MHD

Course Outcomes At the end of the course students will be able to	
CO1	Recognize the need of renewable energy sources.
CO2	Understand various solar thermal energy conversion systems and solar photovoltaic systems in detail.
CO3	Describe different biogas plants, bio-diesel production method and potential of hydrogen as a fuel.
CO4	Explain the working principle of Wind energy systems and ocean thermal energy conversion systems
CO5	Describe the working of Fuel cell system, Geothermal &Magneto hydro dynamic (MHD) power generation systems and Understand the principles of energy conservation.

Syllabus Elective-I Renewable Energy Sources

Contents	No of hours
Unit I Global energy scenario, Indian energy scenario, Environmental aspects of energy utilization, conventional and non-conventional sources of energy, merits, and challenges, Solar Energy: Introduction, solar constant, spectral distribution of solar radiation, beam & diffuse radiation, advantages of solar energy **Solar electrical energy conversion:** Construction and working of solar cells and PV modules, different PV technologies, Photovoltaic system components and different applications	07
Unit II **Solar Thermal Energy Conversion:** Solar flat plate collectors: Types of collectors, liquid flat plate collectors, solar air heaters, Concentric collectors: line focusing, point focusing and non-focusing type, central receiver concept of power generations, compound parabolic collector, comparison of flat & concentric collectors. Solar Ponds, Solar Cookers, Solar energy storage, sensible, latent and thermochemical storage,	07

Unit III **Energy from Biogas**: - Introduction, bio gas generation, fixed dome & floating drum biogas plants, their constructional details, raw material for biogas production, factors affecting generation of biogas, digester design considerations, fuel properties of biogas and utilization of biogas. Bio Mass: Introduction, methods of obtaining energy from biomass, thermal gasification. **Biodiesel:** Types of biodiesel, Trans-esterification process, Properties and application	08
Unit IV **Wind Energy**: Wind characteristics and site selection, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, Wind energy conversion systems; Types of WECS and their characteristics, components, Working of horizontal and vertical axis wind turbine machines, **Ocean Energy**: Tidal power plants: single basin and two basis plants, Variation in generation level ; Ocean Thermal Electricity Conversion (OTEC) ; Electricity generation from Waves : Shoreline and Floating wave systems.	08
Unit V **Hydrogen Energy:** Properties of Hydrogen with respect to its utilization as a renewable form of energy, sources of hydrogen, production of hydrogen, electrolysis of water **Fuel Cell Technology**: Introduction, Principle of working, Types of fuel cells, Fuel cell efficiency **Geothermal energy**: Introduction, classification of geothermal systems, vapour dominated, liquid dominated system, petrothermal systems, magma resources, applications of geothermal energy.	06

References

Text Books Recommended:

1. Non-Conventional Energy Sources, G.D. Rai, Khanna publishers.
2. Non-Conventional Energy Resources: B.H. Khan, Tata McGraw Hill.
3. Solar Energy Utilization, G.D. Rai. Khannapulishers.
4. Industrial Energy Conservation, D. A. Ray, Pergaman press.

Reference Books Recommended:

1. Renewable Energy Sources and Emerging Tech., Kothari. PHI.
2. Solar Energy, S.P. Shukhatme, Tata McGraw Hill Education.
3. Renewable Energy Recourses: Basic Principle and Applications: G.N. Tiwari andM.K. Ghosal, Narosa publication.

RTM Nagpur University- Mechanical Engineering
B.Tech 6TH SEM-(Elective II)
Advanced Manufacturing Techniques-BTME605T
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assess	University Exam	Total	
B.Tech 6th Sem Mechanical	**Advanced Manufacturing Techniques (Elective II)**	3	-	-	03	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	This course is designed to provide students with an overview of a wide variety of non-traditional machining processes for processing of engineering materials.
2	It will help students to learn principles, operations, capabilities, process parameters, economics and application of various non-traditional machining processes, various unconventional welding techniques.
3	It will help students to learn and understand the importance of non-traditional machining processes and unconventional welding techniques.
4	In all to generate interest in learning and develop the ability in students to select and apply suitable processes for an engineering product.
Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Understand and compare the different Non-Traditional machining process with their need, economics and application as well as historical development. Understand the basics of High speed grinding, Hot and Cold machining.
CO2	Understand the basics of Abrasive Jet Machining (AJM), Ultrasonic Machining process and Water Jet Machining.
CO3	Get acquainted with the Electro-Chemical Machining, Electrochemical Grinding, Electric Discharge Machining. Get acquainted with the Electron Beam, Laser Beam and Plasma Arc Machining.
CO4	Know the basics of unconventional welding techniques and Solid Phase welding techniques.
CO5	Get acquainted with the basics of advance casting processes.

SYLLABUS- Advanced Manufacturing Techniques--(Elective II)	
Contents	No of hours
Unit I Non Traditional Machining process: Need, classification & historical development. Economics & application of Non-Traditional machining processes. High speed grinding, Hot and Cold machining. ,	08
Unit II Abrasive Jet Machining (AJM): Mechanics of AJM, process parameters and machining parameters. Ultrasonic Machining process: Mechanics and process parameters. Water Jet Machining.	09
Unit III Electro-Chemical Machining: Electrochemistry of ECM. Electrochemical Grinding, Electric Discharge Machining. Electron Beam, Laser Beam and Plasma Arc Machining.	08
Unit IV Unconventional welding techniques such as Oxyacetylene pressure welding, Atomic Hydrogen welding, Stud welding. Solid Phase welding techniques such as Ultrasonic welding, Friction welding with recent development in Welding, Economics and application of Non-Traditional processes for welding.	10
Unit V Advance casting process: Metal mould casting, continuous casting, squeeze casting, vacuum mould casting, evaporative pattern casting, ceramic shell casting, centrifugal casting, slush casting	10

Books Recommended:

1. Manufacturing Science, Ghosh & Malik, East West Press.
2. Advanced Machining Processes, V.K. Jain, Allied Publishers.
3. Introduction to Micromachining, V.K. Jain, Narosa Publishers.
4. Non-Conventional Material Removal Processes, V.K. Jain, IGNOU.
5. Modern Machining Processes, Pandey, Tata McGraw Hill.
6. Textbook of Production Engineering, P.C. Sharma, S. Chand

Reference Book

1. Advanced Machining Processes (Non-Traditional And Hybrid Machining Processes), Hassan El-Hofy, McGraw Hill.
2. Non-Traditional Manufacturing Processes, G.F.Benedict, Marcel Dekker, New York.
3. Manufacturing Engineering & Technology, Serope Kalpakjian, Pearson.
4. Manufacturing Science, M. l. Khan, PHI.
5. Casting Technology & Casting Alloys, A.K. Chakraborty, PHI

List of tutorials: Tutorials based on above syllabus**.**

RTM Nagpur University-Mechanical Engineering
B.Tech 6th Sem- (Elective-II)
Power Plant Engineering-(BTME605T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assess	University Exam	Total	
B.Tech 6th Sem Mechanical	**Power Plant Engineering (Elective II)**	3	-	-	03	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	To study the basics of power generation systems for different types of power plants(Conventional and Non-Conventional)
2	To estimate the performance of the plants based on cost /KW generation, maintenance etc
3	To study the combined operation of different power plants.
4	To study the environmental impact for all types of power generation
Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Student will able to understand the components, fuel and its associated terminologies and complete working of steam power plant .Also will be able to learn about advantages, drawbacks and environmental impact .
CO2	Students will get acquainted with working of Gas Turbine power plant and Diesel electric power plant, their comparison with other power plants and also Introduce to captive power plant.
CO3	Student will be able to understand the complete working of hydroelectric power plant ,its advantages and comparison with other power plants.
CO4	Student will be able to understand the importance of Nuclear power generation in India, working of various nuclear reactors and complete working of nuclear power plant, waste disposal and its impact on environment and also its comparison with other power plants.
CO5	Student will be able to understand the concept of combined power plant and gets acquainted with the emerging power generation technologies. Also will able to undertake the power load analysis and economic analysis of power generation system.

SYLLABUS - Power Plant Engineering	
Contents	No of hours
Unit I Steam power plant: Introduction to steam power plant and power plant layout, components, functions, plant efficiencies. Fuel and its characteristics, handling, storage, preparation and firing methods. Ash and dust collection and handling. Steam Generators: Classification, construction and working Details of different accessories like air pre heaters ,economizers, super heaters, details of various systems like draught system, feed water treatment system ,condensers, cooling tower and its classification, electrostatic precipitator, fabric filter and bag houses, advantages , disadvantages ,waste disposal, Effect on Environment .	10
Unit II Gas Turbine power plant : Introduction, power plant layouts, open cycle, closed cycle power plants, various components and systems, methods to improve efficiency—intercooling, reheating and regeneration and their combination. Diesel electric power plant: introduction, layout, type of diesel engines, different components and systems, super charging of diesel engine, performance, comparison with other power plants. Introduction to captive power plant. ,	09
Unit III Hydroelectric power plant: Hydrology: - Rainfall runoff, hydrograph, flow duration curve, mass curve. Site selection, classification of hydroelectric power plant, layout, details of different components, selection of prime movers, governing of hydro turbine, advantages and comparison with other power plants. ,	09
Unit IV Nuclear Power Plant:- Introduction to nuclear Engineering, Global scenario, Need of nuclear power in developing countries like India ,terminologies like atomic nuclei, atomic number ,mass number ,binding energy and energy release, types of nuclear reaction and its initiation, fission, fission chain reaction, components of nuclear reactors and its material. Nuclear reactor and its classification in detail. Site selection for location of nuclear power station, present & proposed nuclear plants in India, Nuclear waste disposal and its effect on environment, comparison with other power plants.	09

Unit V Combined operation of different power plants : Binary cycle, Combined operation of different plants and their analysis ,advantages, Cogeneration, Trigeneration Emerging Technologies: MHD power generation, Fuel cell, Solar thermal power plant, Photovoltaic power generation, Geothermal power plant, Wind power plant, Tidal power plant Economics of Power Generation: Load curves, different terms and definitions, peak load, effect of fluctuating loads on power plant design and operation. , ,	09

Sr. No.	List of Tutorials
01	Basic component of steam power plant and modified steam power cycle
02	Steam generators and their component
03	Layout of hydro power plant and site selection
04	Nuclear reactor and nuclear waste disposal
05	Combined power plant and their advantages
06	Economics of power plant and different terms associated with it

References:

Text Books Recommended:

1. Power Plant Engineering, P. K. Nag, Tata McGraw Hill publication.
2. Power Plant Engineering, Domkundwar, Dhanpat Rai & Sons.
3. P. C. Sharma, Power Plant Engineering, Pub S. K. Kataria & Sons
4. Rajput R.K., *A Textbook of Power Plant Engineering*, Laxmi Publication

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Reference Books Recommended:

1. Power Plant Technology, M. M. EI-Wakil, McGraw Hill publication
2. Power Plant Engineering, S.Gautam, Vikas Publication Pvt. Ltd

RTM Nagpur University-Mechanical Engineering
B.Tech 6th Sem- (Elective-II)
Supply Chain Management-(BTME605T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
VI	**Supply Chain Management (Elective-II)**	3	-	-	3	30	70	100	3

Sr. No.	Course Objective
1	Reduce operating expenses
2	Enhance customer satisfaction
3	Improve distribution channel
4	Strengthen financial position of the company & Promote better coordination
5	Regulate proper inventory

Course Outcomes

After Sucessful Completion of the Course Students will be able to:

CO1	Identify Scope and Importance of Supply chain Management
CO2	Understand difference between Transportation & Distribution & their channels
CO3	Plan for Inventories leading to shorter delivery and sourcing time
CO4	Implement strategies and classify them according to requirements
CO5	Plan activities and documentation requirements along with MIS

Syllabus-SUPPLY CHAIN MANAGEMENT-

Contents	No of hours
Unit I Introduction to SCM Meaning, Importance, Overview, Objective, Process Overview, Process tools, Supply chain dynamics, Focus areas in SCM, Change Drivers, Evolution of SCM, Types of Cargoes. Cross docking warehousing, Agile SCM, Green SCM, Maritime SCMs.	8hrs
Unit IISupply Chain Network Design and Demand Management Logistics and SCM Network design, Integrated SCM Planning, Strategic Importance of Logistics/SCM network planning, Factors influencing network design decisions, Major Locational determinants, Framework - Design – and Functions, Types and Functions of Distribution Channel, Physical Distribution Management, Tasks in Physical Distribution Channel, Economic of distribution, Channel Relationships, Logistics service alliances, Alliances, Modelling approaches to Logistics/ Supply chain network design, Strategic Planning of logistics. Supply chain network, Demand Management, Relationship between customer service and demand management, Performance measures for customer service. Demand management process, ,	8hrs
Unit III **Supply Chain Planning, implementation and order processing with IT-**Aggregate planning in a supply chain, Aggregate planning strategies, Planning supply and demand in a supply chain, Planning and managing inventories in a supply chain, Planning for optimal level of product availability, Sourcing/source management, Strategic sourcing management / Transportation management The customer order cycle, Order management system, Order and replenishment cycles, Order processing categories, The logistics information system, The order management system**,** The warehouse management system, The transportation management system. ,	8 hrs
Unit IV Supply Chain Planning and Strategies Supply chain strategies, Strategy classification, Corporate strategy, Logistics strategies, Strategic fit, Achieving strategic fit, Supply chain strategies, Supply chain strategy framework, Supply chain relationships, Customer relationship management, Supply chain integration, Push, Pull and Push Pull systems, Demand-driven strategies, Distribution strategies, Centralised control strategy versus decentralized control strategy ,	8hrs
Unit V Location and Transportation Strategy in Supply Chain The need for long range planning, Major locational determinants, Historical perspectives on location problems, Single facility versus multi facility location, Methods of evaluating location alternatives The role of transportation in a supply chain, Traffic and transportation strategy, Carrier selection decision, Inter-model transportation, Transport documentation, Transportation economics and pricing costing of transportation services, Rate and rating, Transportation management strategy, Transportation Management System (TMS), Transportation services, Transportation cost considerations, Transportation rate profiles, Transportation documents used in International transportation, and Domestic transportation. ,	8hrs

Text Books Recommended:

1. K. ShridharaBhat, Supply Chain Management, Himalaya Publishing House, Latest Edition

2. Sunil Chopra, Peter Meindl, DharamVirKalra Supply Chain Management – Strategy, Planning and Operation, Pearson Latest Edition

Reference Books Recommended:

1. SarikaKulkarni, Ashok Sharma Supply Chain Management – Creating Linkages for Faster Business Turnaround, Tata McGraw-Hill Publishing Company Ltd, Latest Edition
2. 2. James B. Ayers, Supply Chain Project Management – A Structured Collaborative and Measurable Approach, CRC Press, Latest Edition

RTM Nagpur University- Mechanical Engineering
B.Tech 6th Semester-Elective-II
Introduction to Artificial Intelligence (BTME605T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
B.Tech 6th Sem Mechanical	Introduction to Artificial Intelligence (Elective-II)	03	-	-	3	30	70	100	03

Sr. No.	Course Objective The objective of this course is–
1	To create appreciation and understanding the achievements of AI and the theory underlyingthose achievements
2	To create an understanding of the basic issues of knowledge representation

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Demonstrate knowledge of the building blocks of AI as presented in terms of intelligent agents.
CO2	Analyze and formalize the problem as a state space, graph, design heuristics and select amongst different search or game based techniques to solve them.
CO3	To create an understanding of the basic issues of knowledge representation
CO4	Formulate and solve problems with uncertain information using Bayesian approaches.
CO5	Attain the capability to represent various real life problem domains using logic based techniques and

Syllabus –Introduction To Artificial Intelligence (Elective II), 6th Sem, Mechanical	
Contents	No of hours
UNIT-I Introduction: What is AI? History & Applications, Artificial intelligence as representation & Search, Production system, Basics of problem solving: problem representation paradigms, defining problem as a state space representation, Characteristics.	06
Unit II : Search Techniques: Uninformed Search techniques, Informed Heuristic Based Search, Generate and test, Hill-climbing, Best-First Search, Problem Reduction, and Constraint Satisfaction. ,	07
Unit III: Knowledge representation: Knowledge representation Issues: First order logic, Predicate Logic, Structured Knowledge Representation: Backward Chaining, Backward Chaining, Resolution,Semantic Nets, Frames, and Scripts, Ontology. ,	08
Unit IV: Uncertainty: Handing uncertain knowledge, rational decisions, basics of probability, axioms of probability, Baye's Rule and conditional independence, Bayesian networks, Exact and Approximate inference in Bayesian Networks, Fuzzy Logic.Intelligent Agents: Introduction to Intelligent Agents, Rational Agent, their structure, reflex, model-based, goal-based, and utility-based agents, behavior and environment in which a particular agent operates,	08
Unit V Learning: What is learning?, Knowledge and learning, Learning in Problem Solving, Learning from example, learning probabilistic models Expert Systems: Fundamental blocks, Knowledge Engineering, Knowledge Acquisition, Knowledge Based Systems, Basic understanding of Natural language ,	07

References:

Text Books Recommended:

1. E.Rich and K. Knight, Artificial Intelligence, Tata McGraw Hill, 2008.
2. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 3rd edition, PearsonEducation, 2015.
3. Artificial intelligence and soft computing for beginners by Anandita Das Bhattachargee, ShroffPublishers
4. Artificial Intelligence – A Practical Approach : Patterson , Tata McGraw Hill, 3rd Edition

Reference Books Recommended:

1. Introduction to Artificial Intelligence – Charniak (Pearson Education) publication.

RTM Nagpur University- Mechanical Engineering
B.Tech 6th SEM-(Open Elective –I)
Entrepreneurship Development -BTME606T
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
B.Tech 6th Sem Mechanical	**Entrepreneurship Development (Open Elective –I)**	3	-	-	3	30	70	100	03

Sr. No.	Course Objective The objective of this course are–
1	To develop a knowledge on basic concepts of entrepreneurship.
2	To develop a knowledge on affecting parameters of entrepreneurship and it policies.
3	To create a knowledge on preparation of entrepreneurship methodology
4	To get a knowledge on applications of entrepreneurship
5	To know about effective management of entrepreneurship in small scale Industries.
Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	**Apply** the knowledge of entrepreneurship qualities and skills to startup a business
CO2	**Apply** the knowledge of entrepreneurship policies to startup a business
CO3	**Prepare** a feasibility report and evaluation criteria for an entrepreneurship
CO4	**Analyze** marketing strategies of entrepreneurship
CO5	**Apply** preventive measures to be followed for effective management of Entrepreneurship.

Syllabus –Entrepreneurship Development (Open Elective I), 6th Sem, Mechanical	
Contents	No of hours
Unit-I ENTREPRENEURAL COMPETENCE Entrepreneurship concept – Entrepreneurship as a Career – Entrepreneurial Personality -Characteristics of Successful, Entrepreneur – Knowledge and Skills of Entrepreneur.	06
Unit II: ENTREPRENEURAL ENVIRONMENT Business Environment - Role of Family and Society - Entrepreneurship Development Training and Other Support Organizational Services - Central and State Government Industrial Policies and Regulations - International Business.	08
Unit III: BUSINESS PLAN PREPARATION Sources of Product for Business - Prefeasibility Study - Criteria for Selection of Product -Ownership - Capital - Budgeting Project Profile Preparation - Matching Entrepreneur with the Project - Feasibility Report Preparation and Evaluation Criteria.	08
Unit IV: LAUNCHING OF SMALL BUSINESS Finance and Human Resource Mobilization Operations Planning - Market and ChannelSelection - Growth Strategies - Product Launching – Incubation, Venture capital, IT startups.	08
Unit V: MANAGEMENT OF SMALL BUSINESS Monitoring and Evaluation of Business - Preventing Sickness and Rehabilitation of Business Units- Effective Management of small Business.	07

References:

Text Books Recommended:

5. E.Rich and K. Knight, Artificial Intelligence, Tata McGraw Hill, 2008.
6. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 3rd edition, PearsonEducation, 2015.
7. Artificial intelligence and soft computing for beginners by Anandita Das Bhattachargee, ShroffPublishers
8. Artificial Intelligence – A Practical Approach : Patterson , Tata McGraw Hill, 3rd Edition

Reference Books Recommended:

2. Introduction to Artificial Intelligence – Charniak (Pearson Education) publication.

RTM Nagpur University- Mechanical Engineering
B.Tech 6th SEM-(Open Elective –I)
Automobile Engineering -BTME606T
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
VI	Automobile Engineering	3	-	-	3	30	70	100	03

Sr. No.	Course Objective
1	To make the students conversant with fundamentals of automobile systems
2	To develop competencies in the performance analysis of vehicle.
3	To understand the emerging trends in electric vehicles, Hybrid vehicles and fuel cell vehicles
4	To make the students conversant with Automobile Safety Considerations Electrical Systems and Modern Developments in Automobiles.
Course Outcomes **After Sucessful Completion of the Course Students will be able to:**	
CO1	Demonstrate the vehicle construction, chassis, fuel supply system, lubrication system and cooling system in automobile.
CO2	Illustrate the principle and working of Transmission system and clutch, gear box, rear axle drives, fluid flywheel, torque converter.
CO3	Identify the steering, suspension system and brake system.
CO4	Understand the applications of electrical/electronic system of automobile and wheels, tyres.
CO5	Explain the concept of electric vehicles, Hybrid vehicles, fuel cell vehicles and vehicle pollution norms. Appraise the automobile safety system and recent development in automobiles.

Syllabus-Automobile Engineering-

Contents	No of hours
Unit I Introduction: Classification of automobiles, Major components and their functions. Chassis. Engine Power Plant: Constructional features of different types of engines used in automobiles. SI and CI Engine, Four stroke and Two stroke engine. Fuel supply systems, cooling systems, lubrication systems.	7 hrs
Unit II Transmission system: Clutch: Necessity, requirements of a clutch system. Types of Clutches, centrifugal clutch, single and multi-plate clutch, fluid clutch. Gear Box: Necessity of transmission, principle, types of transmission, sliding mesh, constant mesh, synchromesh, transfer gear box, gear selector mechanism. Semiautomatic and automatic transmission. Propeller shaft, universal joint, Hotchkiss drive, torque tube drive. Differential, Rear axles and Front axles.	8hrs
Unit III Steering systems: Principle of steering, steering geometry and wheel alignment, Power Steering. Under steer, Over-steer. Suspension systems: Need, conventional suspension, Independent suspension System, Active suspensions. Brakes: Function, Classification, Basic Components. Drum Brakes, Disc Brakes, Hydraulic brakes, Air Brakes, ABS.	8 hrs
Unit IV Electrical Systems: Battery, magneto and electronic ignition systems, Automobile air-conditioning. Automotive lighting circuit. Wheels and Tyres: Types of wheels, wheel dimensions, tyre, desirable tyre properties, types of tyres, comparison of radial and bias-ply tyres, factor affecting tyre life.	7hrs
Unit V Electric vehicles, components of EV, EV Batteries, EV Chargers. Hybrid vehicles. Vehicle Pollution Control: cause and types of Emissions from Vehicle, Euro and Bharat Stage norms. Automobile Safety Considerations and Modern Developments in Automobiles: Requirements of automobile body, Vehicle Safety Necessity, active and passive safety, Restrain Systems (seatbelts), Air Bags, crash worthiness. Recent advances in automobiles such as, collision avoidance, intelligent lighting, navigational aids, Automatic Cruise Control and Parking Assistance system.	8hrs

Text Books Recommended:

1. Automobile Engineering Vol. I & II, Kirpal Singh, Standard Publishers, Delhi

2. Automobile Engineering, R.K.Rajput, Luxmi Publications, New Delhi

3. Automobile Engineering R.B. Gupta, Satya Prashan, New Delhi

4. Course in Automobile Engineering, Sharma R. P, Dhanpat Rai and Sons, New Delhi, 1998.

Reference Books Recommended:

1. Automobile Mechanics, Crause, W.H., Tata McGraw Hill, New Del hi, 2007.
2. Vehicle and Engine Technology, Heinz Heisler, Arnold, London, 1999.
3. Automotive Engines, Srinivasan S., Tata McGraw Hill, New Delhi, 2001

RTM Nagpur University- Mechanical Engineering

B.Tech 6th SEM-(Open Elective –I)

Project Evaluation & Management -BTME606T

Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
B.Tech 6th Semester Mechanical	Project Evaluation & Management	3	-	-	3	30	70	100	03

Sr. No.	Course Objective The objective of this course is–
1	To develop an understanding towards a structured approach for every unique project undertaken in the industrial context about its need, concept, tools and techniques of project management approach
2	To develop working knowledge of the technical and financial aspects of project management decisions. Increase awareness and strengthen skills in applying participatory methods to project management.
3	Understand the project management lifecycle and be knowledgeable on the various phases from project initiation through closure.

Course Outcomes

After successful completion of this course the student will be able to:

CO1	Utilize the use of a structured approach for each and every unique project undertaken including utilizing project management concepts, tools, and techniques.
CO2	Apply participatory methods to project management.
CO3	Estimate network scheduling and network planning
CO4	Manage lifecycle on the various phases from project initiation through closure.
CO5	Estimate project Costs, Earned Value Analysis, Monitoring Project Progress, and Project Appraisal.

SYLLABUS	
Contents	No of hours
Unit I : Definition & Characteristics of Project Performance Parameters: Time, Cost & Quality. Classification of Projects: Sector based, Investment based, Technology based, Cause based, Need based - Balancing, Modernization, Replacement, Expansion & Diversification. Project Life Cycle Phases – Concept/Initiation Phase: Parameters Involved in Project Identification. Sources of New Project Ideas. Governmental Framework for Identification of Opportunities, Incentives from state & central govt.; Import-substitution projects.	09
Unit II Project Conceptualization & Feasibility Analysis Project Definition Phase: Project Formulation & Feasibility. Types of Feasibility Studies – Pre-feasibility, Support/Functional Feasibility Study. Preparation of Project Feasibility Report & Specification; Aspects of Project Feasibility Managerial/Organization: Promoters Background, Criteria of Evaluation, Marketing/Commercial: Demand & Supply, Competition, Market Survey, Porter's 5 Forces, Operational/Technical: Process, Technology, Location, Capacity, Labour, and Raw Material & Utility Availability. Financial: Cost of Project, Means of Finance, Financial Projections	09
Unit III Project Planning- Development of Project Network; Project Representation; Consistency and Redundancy in Project Networks; Project Scheduling- Basic Scheduling Project Scheduling with Probabilistic Activity Times. Planning & Organization Phase: Project Planning, Scheduling & Monitoring, Statement of Works, Project Specifications, Work Breakdown Structure, Network Analysis & Duration Estimating Network Diagrams – PERT/CPM, Estimate Activity Times, Milestone Scheduling.	09
Unit IV Project Cost Estimation: Need, Causes of Cost & Time Overruns. Nature of Cost Estimates, Types of Project Cost Estimates, Estimation of Manpower & Utilities. Project Budgeting & Control, Earned Value Management System: Concept of AC, PV, EV, Variances, etc. Contract Management: Responsibility Sharing Matrix, Types of Contract Payments, Risk Factors in Contracts – Contractor & Owner. Project Management Information System and Control, Management Pitfalls.	09
Unit V Project Implementation & Control Implementation Phase: Activities Involved: Erection & Commissioning, Installation, Trial Runs & Commencement of Commercial Production. Cleanup/Shutdown Phase: Handover to Client, Settlement of Accounts. Project Risk Management, Responsibility Sharing Matrix, Critical Chain Project Management – Critical Path vs Critical Chain, Concept of Buffers – Project buffer, resource buffer, feeding buffer.	09

References:

Text Books Recommended:

1.Narendra Singh; Project Management & Control; Himalaya Publishing House, Mumbai

2 S. Chaudhary, Project Management, Tata McGraw Hill

3. Prasanna, C; Projects: Preparation, Appraisal, Budgeting & Implementation, Tata Mc-Graw Hill,

New Delhi, (1987).

4 Chas R.B., Aqulino, N.J. and Jacob,F.R., Production and Operations Management:

manufacturing and services, Tata McGraw Hill, New Delhi (1999).

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Reference Books Recommended:

1.Maylor H, Project Management, Pearson Education Asia, New Delhi, (2009).

2. Cleland D, Project Management, Tata Mc-GrawHill, New Delhi, (2007).

RTM Nagpur University
B.Tech. 6th Semester
Open Elective – I: Operation Research Techniques (BTME606T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
VI	Operation Research Techniques	3	-	-	3	30	70	100	03

Sr. No.	Course Objective The objective of this course is–
1	To study the different OR tools.
2	Study to apply appropriate model to a given situation.
3	Formulate the problem.
4	Solve and analyze the problem.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Formulate and obtain the optimal solution for Linear Programming problems.
CO2	Identify, formulate and obtain optimal solution using transportation and assignment model
CO3	Formulate Network models for service and manufacturing systems, and apply operations research techniques and algorithms to solve these Network problems
CO4	Optimize the problem using Queuing model and Inventory model.
CO5	Optimally arrange the machine/job in a sequence and also simulate the real life problem.

SYLLABUS	
Contents	No of hours
Unit I Introduction to O.R. & basic O.R. Models, Characteristics, phases & Methodology of O.R., Limitations & Applications. Linear Programming: Introduction, Linear programming problem formulation, LPP Solution by Graphical Method, Simplex Method.	07
Unit II Transportation Model: Formulation, Basic feasible solution using different methods (North-West corner, Least Cost, Vogel's Approximation Method), Optimality method, Unbalanced Transportation Problem. Assignment Model: Formulation, unbalanced assignment problem, Variants of Assignment Problems.	08
Unit III Network Model: Drawing of Network, CPM & PERT, probability of completion of project, Cost Analysis of Project, and Concept of Crashing. Allocation & updating of Network.	07
Unit IV Queuing models: Poisson arrivals and Exponential service times – Single channel models (MM1) and Multi channel models. (No derivation expected) Inventory Control Model: Introduction and inventory management concepts, Economic Order Quantity model (EOQ), Economic Production Quantity model (EPQ), model for purchase allowing for shortages, ABC analysis.	08
Unit V Sequencing Model: Introduction, n job two machines problem, n job 3 machines problem, 2 jobs m machine problem. Simulations: Concept, applications in waiting line situations, inventory and network.	08

References:

Text Books Recommended:

1. Operation Research, Heera & Gupta, S Chand Publications.
2. Operation Research, J. K. Sharma, Macmilan Publishers.

Reference Books Recommended:

1. Operation Research, Hamdy Taha, Prentice Hall.
2. Operation Research, Liberman, McGraw Hill Publications .
3. Operation Research , S D Sharma, Kedarnath Ramnath & Co.
4. Operations Research , Pannerselvam: Prentice Hall of India 2010.

RTM Nagpur University

B.Tech. 6th Semester

Open Elective – I: Industrial Safety & Environment (BTME606T)

Proposed Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessm	University Exami	Total	
VI	Industrial Safety & Environment	3	-	-	3	30	70	100	3 Hrs

Sr. No.	Course Objective The objective of this course is–
1	To learn about basic fundamentals of industrial safety and its importance for protecting an environment against damages from industrial accidents.
2	To gain an understanding of management responsibilities and the legal aspects of industrial safety.
3	To acquire the knowledge of safe working practices & emergency preparedness in industrial framework.
4	To minimize financial losses, property damage and human safety in industrial environment by applying principles of industrial safety.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Gain the knowledge about industrial safety protocols and its different dimensions.
CO2	Know about an administrative angle ofthe industrial safety.
CO3	Understand the legal aspects of the safety.
CO4	Acknowledge the safe working practices.
CO5	Be aware of emergency preparedness in work environment.

SYLLABUS	
Contents	No of hours
Unit I –Safety, Health and Environment - Safety, Health and Environment Policy - Fundamental of Safety - General Instruction - Accident CausesIdentification - Hazards Identification (Fire, Chemical, Mechanical, Electrical, Radiation, Environmental) - Safe Engineering Designs	8
Unit II–Organization, Administration and Management responsibility - Objective - Basic Safety Programme - Safety Department - Responsibilities of Top Management, Middle Management & Workers - Responsibilities of Government&Public Authorities - Responsibilities of Social Organizations	7
Unit III - Legal aspect of the Safety - The Factories Act 1948 - The Maharashtra Factories Rules 1963 - The Dangerous Machines (Regulation Act) 1983 - The Dangerous Machines (Regulation Rules) 2007 - The Maharashtra Factories (Control of Industrial Major Accident Hazards) Rules 2003 - The Maharashtra Factories (Safety Audits) Rules 2014	8

Unit IV – Safe working practices - Housekeeping - Safety Manual - Occupational Health and Safety Policy - Standards Operating Procedures (SOPs) - Work Permit Systems - Medical Management of Accident - Safety Trainings - Personnel Protection Equipment (PPEs)	8
Unit V –Emergency preparedness - Site Specific Details - Duties and Responsibilities of Key Personnel - Identification of Emergencies and Accident Scenario - Declaration and Termination of Emergency - Resources-evacuation / Transport - Communication Facilities - Medical Care - Periodic Drills / Exercises - Public Awareness Programmers - Emergency Control Centre Duties	8

References:

Text Books Recommended:

1.Industrial Safety, Health and Environment Management Systems by R.K. Jain and Prof. Sunil S. Rao, Khanna Publishers.

2. Industrial Safety and Environment by Amit Gupta, Laxmi Publications (P) Ltd.

3. Industrial Safety and Maintenance Management by M. P. Poonia and S. C. Sharma, Khanna Book Publishing Co. (P) Ltd.

Reference Books Recommended:

1. Safety & Health for Engineers- Roger. L. Brauer, John Wiley Sons 2006

2.Accident Prevention Manual for Industrial Operation , N.S.C Chicago 1982

3.Publication from International Standard Organization like ISO, OSHA, NEBOSH

4. Gerad Kiely, Environmental Engineering, McGraw Hill Education (India) Private Limited

RTM Nagpur University- Mechanical Engineering
B.Tech 6th Semester (Mandatory Course)
Environment Science (BTME607T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Audit	GRADES			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
B.Tech 6th Sem Mechanical	**Environment Science**	02	-	-	00	Grades O,A,B,C	Grades O,A,B,C	--	--

Sr. No.	Course Objective The objective of this course is–
1	This course provides an integrated and interdisciplinary approach to the study of environment and solutions to environmental problems. This course will spread awareness among the students about environmental issues and shall alert them to find solutions for sustainable development.

GUIDELINES FOR EVALUATION OF ENVIRONMENTAL STUDIES SUBJECT
(As per Ordinance No. 2 of 2012)

In view of the above entire course the students in terms of batches of 20 students each may be assigned a project work encompassing People_s Bio-diversity Register (PBR) of any Gram Panchayat as per the format of Bio-diversity Authority of India under the guidance of a teacher. The PBR should be evaluated for 100 marks.

The result shall be declared in grades as follows:

Grade O: above 75 Marks; Grade A: 61–75 Marks; Grade B: 51-60 Marks; Grade C: 40-50 Marks

Syllabus Environmental Studies, 6th Semester, Mechanical Engineering	
Contents	No of hours
Unit I : Definition, scope and importance; Need for public awareness -Institutions in environment,people in environment.	04
Unit II: Renewable and non-renewable and associated problems; Role of an individual in conservation ofnatural resources; equitable use of resources for sustainable lifestyles.	04
Unit III: Concept of an ecosystem - understanding ecosystems, ecosystem degradation, resource utilization, Structure and functions of an ecosystem- producers, consumers) and decomposers. Energy flow in the ecosystem - water, carbon, oxygen, nitrogen; and energy cycles, integration of cycles in nature. Ecological succession; Food chains, food webs and ecological pyramids; Ecosystem types - characteristic features, structure:, and functions of forest, grassland, desert and aquatic	04
Unit IV: Introduction - biodiversity; at genetic, species and ecosystem levels Bio-geographic classificationof India Value of biodiversity - Consumptive use value, productive use .value, social, ethical, moral,aesthetic and optional value of biodiversity .India as a mega-diversity nation; hotspots of biodiversity Threats to bio-diversity - habitat loss, poaching of wildlife, man-wild life conflicts. Common endangered and endemic plant and animal species of India. Insitu and Exsitu conservation of biodiversity	04
Unit V Definition; Causes, effects and control measures of air, water, soil, marine, noise and thermal pollutions and nuclear hazards. Solid waste management - Causes, effects and control measures of urban and industrial waste. Roleof individual and institutions in prevention of pollution. Disaster management Floods, Earth quacks, Cyclone and land slides	04

References:

Text Books Recommended:

A Text Book of Environmental Studies for Undergraduate Courses, Erach Bharucha, University Press (India) Pvt. Ltd., Hyderabad intelligence‖, McGraw-Hill Book Co., 1987.

RTM Nagpur University-Mechanical Engineering
B. Tech. 7th Semester
Elective – III: Mechatronics (BTME701T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Exami	Total	
VII	**Mechatronics**	3			3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	to understand key elements of mechatronics systems, to identify various inputs and output devices in an automated system
2	to understand and draw ladder diagrams, to understand interfacing of input and output devices, to get awareness about actuating systems, microprocessors & microcontroller
3	to understand the working of mechatronics systems & shall acquire the insight to build the mechatronics systems.

Course Outcomes

After successful completion of this course the student will be able to:

CO1	Identify scope and elements of mechatronics design process and types of control system
CO2	Study various actuating systems of mechatronic applications
CO3	Identify system interfacing requirements and data acquisition using signal conditioning and signal processing techniques
CO4	Study digital logic for development of microprocessor
CO5	Development of ladder diagram and programming using PLC for interfacing between hardware and software.

SYLLABUS

Contents	No of hours
Unit I **Sensors and Transducers-** Types and its Application, 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 feedback control system, Example of any one Mechatronics Systems in detail	7

Unit II **Electrical Actuating Systems:** Mechanical switches and relays, solenoids, state switches-solenoids, DC Servomotors, Stepper motor, Induction Motors, speed control, pulse four-quadrant servo drives, Pulse width modulation (PWM) frequency drive, vector drive **Pneumatics & Hydraulic Actuating Systems:** Pneumatics & Hydraulic Systems, directional control valves, pressure control valves, servo and proportional control valves, Process control valves, cylinder sequencing and cascade control, rotary actuators, Identifications of graphical symbols for Pneumatic and Hydraulic circuits.	7
Unit III **I/O hardware and Software at the Microprocessor:** Level and commutation, I/O operations, Data width, interfacing requirement, Buffers, Handshaking, Polling and interrupt, Digital communication, Parallel communication, Serial communication, Peripheral interface device (PIA), Analogue interfacing. Analogue to Digital and Digital to Analogue Conversion: Introduction to digital signal processing (DSP), Data flow in DSPs, Block diagrams and typical layouts, Components of interconnections and Impedance Matching: Impedance characteristics, Cascade connection of devices, Impedance matching in mechanical systems, interfacing microcontroller output with actuators. **Interfacing Motor Drives:** Drives units- DC drives, Variable frequency drives (VFD), Scalar and Vector drives, Stepper motor driver and controller **DAQs:** Data acquisition systems (DAQS), data loggers, Supervisory control and data acquisition (SCADA), Functionality,Communication methods, applications, development, evaluation and benefits of SCADA.	7
Unit IV **Digital logic:** Number system, Logic gates, Boolean algebra, Karnaugh map, Applications of gates, Sequential logic. **Introduction – Components of Microprocessors:** Number systems, arithmetic operations on binary numbers, 8-bit, 16-bit, 32-bit microprocessors 8085 Microprocessor: Pin configurations of 8085, architecture of the execution unit, memory segmentation in 8085, architecture of bus interface unit of 8085, building of microprocessor subsystems.	8
Unit V **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.	7

References:

Text Books Recommended:

1. Mechatronics - Integrated Mechanical Electronics System, K.P. Ramachandran, Wiley India Pvt. Ltd. New Delhi
2. Mechatronics & Microprocessors, K.P. Ramachandran, Wiley India Pvt. Ltd., New Delhi.
3. Programmable Logic Controllers, John W Webb and Ronald A Reis, Prentice Hall, Inc., 1999.
4. Mechatronics, Bolton W, Pearson Education, Second Edition, 1999.
5. Pneumatic Application, Kemprath Reihe, Wemer Depper and Kurt Stoll, Vogel Buch Verlag Wurzbutg, 1987.
6. An Introduction to MEMS Engineering, Nadim Maluf & Kirt Willams.
7. RF MEMS & their Applications, Vardhan, Willey India Pvt. Ltd.
8. MEMS: Introduction and Fundamentals, Mohamed gad-el-hak, CRC Press, 2nd ed.

Reference Books Recommended:
1. Pneumatic Application, Wemer Deppert and Kurt Stoll, Kemprath Reihe, Vovel Verlag , Wurzburg, 1976.
2. Pneumatic Tips, Festo K G, Festo, Germany, 1987.
3. Mechatronics, N. P. Mahalik, Mc Graw-Hill Education.
4. Mechatronic Systems Fundamentals, Rolf Isermann, Springer, 2003.
5. Mechatronics: Introduction, Robert H Bishop, Taylor and Francis, 2006.
6. Mechatronics System Design, D. Shetty, Cengage Learning (Indian Ed.)

RTM Nagpur University-Mechanical Engineering
B.Tech. 7th Semester
Elective – III: Mechatronics (BTME701P)
Syllabus (Practical)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
VII	Mechatronics Lab			2	1	25	25	50

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Identify and explain various solid state electronic devices, sensors and actuators.
CO2	Describe and demonstrate the conversion of signal from Analog to digital and vice versa.
CO3	Implement ladder logic programming using PLC to develop various mechatronics applications
CO4	Interpret and demonstrate various electro-pneumatic and electro-hydraulic systems using graphical symbols and circuit diagram.
CO5	Identify and explain various solid state electronic devices, sensors and actuators.

List of Practical's

Sr. No.	List of Practical's
01	Identification & study of solid state electronic devices.
02	Identification, study & demonstration of different sensors.
03	Identification, study & demonstration of different actuators.
04	Demonstration of working of various digital to analog and analog to digital Converters.
05	Development of ladder diagram, programming using PLC for any of the following.
	a) Motor start and stop by using two different sensors.
	b) Simulation of a pedestrian traffic controller.
	c) Simulation of four road junction traffic controller.
	d) Lift / elevator control.
	e) Washing machine control.
	f) Tank level control.

	g) Soft drink vending machine control
	h) Any other suitable application.
06	5. Trace, interpret and demonstrate working of electro pneumatic systems.
07	6. Trace, interpret and demonstrate working of electro hydraulic systems.
08	7. Demonstration of vibration measurement system using data acquisition system and LabVIEW software.

Suggested References:

Text Books Recommended:

1. Mechatronics - Integrated Mechanical Electronics System, K.P. Ramachandran, Wiley India Pvt. Ltd. New Delhi
2. Mechatronics & Microprocessors, K.P. Ramachandran, Wiley India Pvt. Ltd., New Delhi.
3. Programmable Logic Controllers, John W Webb and Ronald A Reis, Prentice Hall, Inc., 1999.
4. Mechatronics, Bolton W, Pearson Education, Second Edition, 1999.
5. Pneumatic Application, Kemprath Reihe, Wemer Depper and Kurt Stoll, Vogel Buch Verlag Wurzbutg, 1987.
6. An Introduction to MEMS Engineering, Nadim Maluf & Kirt Willams.
7. RF MEMS & their Applications, Vardhan, Willey India Pvt. Ltd.
8. MEMS: Introduction and Fundamentals, Mohamed gad-el-hak, CRC Press, 2nd ed.

Reference Books Recommended:

1. Pneumatic Application, Wemer Deppert and Kurt Stoll, Kemprath Reihe, Vovel Verlag , Wurzburg, 1976.
2. Pneumatic Tips, Festo K G, Festo, Germany, 1987.
3. Mechatronics, N. P. Mahalik, Mc Graw-Hill Education.
4. Mechatronic Systems Fundamentals, Rolf Isermann, Springer, 2003.
5. Mechatronics: Introduction, Robert H Bishop, Taylor and Francis, 2006.
6. Mechatronics System Design, D. Shetty, Cengage Learning (Indian Ed.)

RTM Nagpur University-Mechanical Engineering
B.Tech. 7th Semester
Elective – III: Computer Aided Design
(BTME701T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Exam	Total	
VII	Computer Aided Design (El- III ME)	3			3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
	Use of computer graphics and its analytical capacity for optimum design and solid modeling of the mechanical components along with its analysis using finite element method
Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	To design graphic system by selecting appropriate input output devices for any graphical applications. Also, develop a logic for various geometrical entities used in modeling software by giving appropriate mathematical treatment, put it into an algorithm and convert an algorithm into a computer program.
CO2	To develop a logic for various transformations on any 2D & 3D geometric objects giving appropriate mathematical treatment, put it into an algorithm and convert an algorithm into a computer program
CO3	To Explain the different geometric modeling techniques, synthetic curves & methods of assembly modeling. Also understand parametric representation of space curves and surfaces.
CO4	To understand numerical analysis technique called finite element method and apply it on one dimensional problem to determine various field variances.
CO5	Apply finite element method on truss and beams to determine various fields variances such as nodal displacement, reaction force, element stress etc.

SYLLABUS	
Contents	No of hours
Unit I Introduction of CAD, features of CAD software and their selection Difference between Conventional & CAD design and simple algorithms for the generation of basic geometric entities like line, circle by using parametric & non-parametric equations. Introduction to 2D viewing, window and viewport, line clipping & polygon clipping (no algorithms).	7
Unit II 2D transformation: Translation, Scaling, Rotation, Reflection & Shear, Concept of homogeneous representation & concatenation. Inverse Transformation (enumeration of entity on graph paper) 3D Transformation: Translation, Scaling, Rotation about principle and arbitrary axis, Reflection about principle and arbitrary plane etc.	7
Unit III Techniques for Geometric Modeling: Wire frame modeling, surface modeling, solid modeling methods: primitive creation function, constructive solid geometry, B-representation technique, etc. Introduction to Analytic Curves, Synthetic Curves: Bezier curve, Cubic spline curve and B-Spline curve. Parametric representation of surfaces Assembly modeling: Representation, mating conditions, representation schemes, generation of assembly sequences and importance of precedence diagram. ,	7
Unit IV Finite Element Analysis: One Dimensional Problem: Fundamental concept of finite element method, Plain stress and strain, Finite Element Modeling, Potential Energy Approach, Galerkin Approach, Coordinate and Shape function, Assembly of Global Stiffness Matrix and Load Vector, Properties of Stiffness Matrix, Finite Element Equations, Quadratic Shape Function, Temperature Effects, Torsion of a circular shaft. ,	8
Unit V Truss & Two Dimensional FEM: Plane truss problems, Finite element method for beams: Introduction, element formulation, load vector, boundary condition, shear force and bending moment, beams on elastic support. ,	7

References:

Text Books Recommended:

1.CAD/CAM Theory and Practice, ZeidIbrham, Tata McGraw Hill.
2. CAD/CAM, Principles and Applications, P.N. Rao, McGraw Hill.
3. Computer Graphics in Mathematical Approaches, D P Kothari, G K Awari, D DShrimankar& A R Bhende, New Age International.
4. Computer Aided design and Manufacturing, Lalit Narayan, Rao&Sarcar, PHI pub.
5. Introduction to Finite Elements in Engineering, Chandrupatla T. R. and Belegunda A.D., Prentice Hall India.
6. Finite Element Method with application in Engineering, Y.M. Desai, T.I. Eldho, A.H. Shah, Pearson publication.
7. Optimization: Theory and Practice, Joshi M.C, Narosa Publication.

Reference Books Recommended:

1. Computer Graphics, D. Hearn & M.P. Baker, Pearson.
2. Computer Graphics, S. Harrington, McGraw Hill.
3. Computer Control of Manufacturing Systems, YoramKoren, McGraw Hill.
4. First Course in the Finite Element Method, Daryl Logan, Cengage Learning.
5. Mathematical Elements for Computer Graphics, Dravid F Rogers, J. Alan Adams, McGraw Hill.
6. Schaum's Outline Series: Theory & Problems of Computer Graphics, Roy A. Plastock, Gordon Kalley, McGraw Hill.
7. Computer Graphics & Product Modeling for CAD / CAM, S.S. Pandey, Narosa publication.
8. Optimum Design of Mechanical Elements, R. C. Johnson, John Wiley & Sons.

RTM Nagpur University-Mechanical Engineering
B.Tech. 7th Semester
Elective – III: Computer Aided Design
(BTME701P)
Syllabus (Practical)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
VII	Computer Aided Design (El- III ME)			2	1	25	25	50

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Write logic in the form of an algorithm to construct geometric entities and generate a computer program for the same.
CO2	Develop finite element model of an engineering problem, apply loading conditions and boundary conditions, and solve it for analysis of its performance in simulated condition using Analysis software
CO3	Write computer program for 2D and 3D Transformation on any object.
CO4	Generate 2-D and 3-D geometric model of Engineering object using construction and modifying commands using CAD software.

Sr. No.	List of Practicals Minimum Six Practicals on the standard CAE packages like HYPERWORKS, ANSYS, NASTRAN, ABAQUS, or any other relevant software or freeware
01	2-D Geometric modeling of an Engineering object, demonstrating Boolean operations like add, subtract and PAN, ZOOM, ROTATE commands
02	3-D Geometric Modeling of an Engineering object, demonstrating extrude, revolve and loft commands.
03	Generation of at least two simple solid models showing geometric properties using any CAD software.
04	Generation of any Assembly model along with animation.
05	Static structural analysis using 1-D bar element by standard FE package.
06	Static structural analysis using 1-D truss element by standard FE package.
07	Static structural analysis using beam element by standard FE package.
08	Programs for generation of entities like Line, Circle, Ellipse using Bressenham'salgorithms.
09	Programs for 2-D & 3-D transformations.

10	Generation of Bezier curve in CAD software using parametric equation.
11	Generation of cubic spline curve in CAD software using parametric equation.

Suggested References:

1. CAD/CAM Theory and Practice, ZeidIbrham, Tata McGraw Hill.
2. Introduction to Finite Elements in Engineering, Chandrupatla T. R. and Belegunda A.D., Prentice Hall India
3. Optimum Design of Mechanical Elements, R. C. Johnson, John Wiley & Sons.

RTM Nagpur University-Mechanical Engineering
B.Tech. 7th Semester
Elective – III: Advancements in Automobile Engineering (BTME701T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
VII	Advancements in Automobile Engineering	3	-	-	3	30	70	100	3

Sr. No.	Course Objective The objective of this course are–
1	To Know about automobile history and its development and to make the students conversant with fundamentals of automobile systems
2	To familiarize students with the power transmission, brakes, steering and suspension systems used in automobile.
3	To understand the emerging trends in electric vehicles, Hybrid vehicles, fuel cell vehicles and vehicle Maintenance
4	To make the students conversant with Automobile Safety Considerations Electrical Systemsand Modern Developments in Automobiles.
Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Classify and identify the main components of automobile. Explain the construction and working of I. C. Engine, fuel supply systems, cooling systems and lubrication systems used in automobile.
CO2	Illustrate the functions of different types of automobile clutches and gear boxes and their applications.Explain the working of transmission system, its components such as propeller shaft, drives, differential and axles.
CO3	Describe the working of different steering systems, steering gear boxes and suspension systems. Identify the different components of steering, suspension and brake systems with their comparisons and applications.
CO4	Demonstrate the importance of safety considerations in automobiles and outline the recent technological development in automotive safety. Describe the automobile maintenance, Trouble shooting, service procedures, Overhauling and Engine tune up.
CO5	Explain the working of Electric Car, Hybrid Electric vehicles and Fuel cell vehicles. Describe the importance of Alternative energy sources,Vehicle Pollution norms and different methods of pollution control

Syllabus- Elective – III: Advancements in Automobile Engineering (BTME701T)

Contents	No of hours
Unit I: **Introduction to Automobile, Chassis and Frame:** Layout of chassis and its main components. Types of frames, conventional Frames and unitized chassis, articulated and rigid vehicles. **Power Plant:** Constructional features of different types of engines used in automobiles. Fuel supply systems, cooling systems, lubrication systems.	7

Unit II **Transmission system:** **Clutch:** Necessity, function and requirements of a clutch. Types of Clutches, centrifugal clutch, single and multi plate clutch, fluid clutch. **Gear Box:** Necessity of transmission, principle, types of transmission, sliding mesh, constant mesh, synchromesh, transfer gear box and gear selector mechanism. Torque converter, semiautomatic and automatic transmission. Propeller shaft, universal joint, Hotchkiss drive, torque tube drive. Differential – Need and types. Rear axles and Front axles.	8
Unit III **Brakes, Steering systems and Suspension system:** **Brakes:** Need & types, mechanical, hydraulic & pneumatic brakes, electrical brakes, engine exhaust brakes, drum and disc brakes, comparison and details of components , ABS system. **Steering System:** principle of steering, center point steering, steering linkages, steering geometry, wheel alignment, wheel balancing and electronic power steering. **Suspension systems:** Function of different springs, conventional suspension, Independent suspension, Telescopic shock absorber, linked suspension and pneumatic suspension system.	8
Unit IV **Automobile Safety Considerations and Modern Developments in Automobiles:** Requirements of automobile body, Vehicle Safety, Necessity, active and passive safety, Restrain Systems (seatbelts), Air Bags, crash worthiness. Recent advances in automobiles such as Active suspension, collision avoidance, intelligent lighting, intelligent highway system, navigational aids, Automatic Cruise Control and Parking Assistance system.	7
Unit V **Introduction to Hybrid Electric Vehicles (HEV**): History of HEV, Modern day HEV, what are HEV? Working of HEV, Brief Description of Major components in an HEV, Degree of Hybridization in HEV, Advantages/Disadvantages. HEV Power-train. Technologies used for Increasing Energy Efficiency in HEV, Regenerative braking system/KERS, Start-Stop system. **Recent Advancement in Automobile:** Electric vehicles, components of EV, EV Batteries, EV Chargers, EV controllers, Hybrid vehicles, types of hybrid and Fuel cell vehicles.	8

References:

Text Books Recommended:

1. Automobile Engineering Vol. I & II, Kirpal Singh, Standard Publishers, Delhi.
2. Automobile Engineering by R.K.Rajput, Laxmi Publications, New Delhi.
3. Automobile Engineering by R.B. Gupta, Satya Prashan, New Delhi.
4. Course in Automobile Engineering by Sharma R. P, DhanpatRai and Sons, New Delhi.
5. Basic Automobile Engineering by C P Nakra, DhanptRai and co. Ltd, New Delhi

Reference Books Recommended:

1. Automotive Mechanic by William Crouse and Donald Anglin, Tata McGraw Hill, New Delhi.
2. Vehicle and Engine Technology by Heinz Heisler, Arnold, London.
3. Automotive Engines by Srinivasan S., Tata McGraw Hill, New Delhi.
4. Automobile engineering by Dr. V. M. Domkundwar, DhanptRai and co. Ltd, New Delhi

RTM Nagpur University-Mechanical Engineering
B.Tech. 7th Semester
Elective – III: Advancements in Automobile Engineering Lab (BTME701P)
Syllabus (Practical)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
						Continual Assessment	University Examination	Total
		L	T	P				
VII	**Advancements in Automobile Engineering**	-	-	2	1	25	25	50

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Make students understand the basic concepts, requirement and working of various components of automobile.
CO2	Make students understand the assembling and disassembling procedure of Engine.clutch,brakes and the process of wheel alignment, balancing and battery testing.
CO3	Enable students to understand and identify components of transmission system, brakes, steering and suspension systems.
CO4	Aware students about automotive electronics and recent technologiesused in automobiles.
CO5	Aware students about the importance of safety considerations in automobiles, automobile maintenance and overhauling.

List of Practicals (Out of given list any Eight practicals to be performed)

Sr. No.	List of Practical's
01	To prepare a report on visit to automobile engineering industry/ service center / any industry related to automobile components or systems.
02	Demonstration and study of Chassis layout and frame used in any one automobile.
03	To assemble and disassemble of single or multi cylinder engine and identify its components
04	To assemble and disassemble multi plate clutch
05	To assemble and disassemble mechanical brakes and identify its components.
06	To identify battery condition using battery tester and its restoration.
07	To prepare a report on process of wheel alignment and balancing
08	Demonstration and study of air suspension system. Identify its components and study about the functions of each components.

09	Demonstration and study of different types of steering systems
10	Study of heating, ventilation and air conditioning system in a given car
11	To prepare a report on pre-delivery inspection (PDI),free service schedule of a Carwith checklist of work to be carried in PDI. 1^{st},2^{nd} and 3^{rd}free service.
12	Detail study of electric vehicle. Identify its components and study about the functions of each components.

Suggested References:

1. Basic Automobile Engineering by C P Nakra, Dhanpat Rai and co. Ltd, New Delhi .
2. Automobile Engineering Practicals by C P Nakra, Dhanpat Rai and co. Ltd, New Delhi
3. Automobile Engineering Vol. I & II by Kirpal Singh, Standard Publishers, Delhi
4. Automobile engineering Vol. I and II by P S. Gill, S. K. Kataria and sons, New delhi.

RTM Nagpur University-Mechanical Engineering
B.Tech. 7th Semester
Elective – III: Computational Fluid Dynamics (BTME701T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessm	University Exami	Total	
VII	Computational Fluid Dynamics	3	-	-	3	30	70	100	03

Sr. No.	Course Objective The objective of this course is–
1	To impart knowledge on the fundamental aspects of computational methods used in the field of fluid flow and heat transfer.
2	To discusses in detail the types of governing equations and their methods of solutions, types of boundary conditions, equations for turbulent flow and turbulent kinetic energy.
3	To discuss FDM and FVM and their applications in the field of diffusion, convection - diffusion and flow field problems.
Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Interpret the governing equations of the fluid flow, heat transfer & their applications.
CO2	Choose methods and analysis techniques used in computational solutions of fluid mechanics and heat transfer problems.
CO3	Explain the interaction of physical processes and numerical techniques.
CO4	Develop mathematical model and write algorithms for the different fluid flow and heat transfer problems.
CO5	Apply Finite differences and finite volume techniques.

SYLLABUS - Elective – III: Computational Fluid Dynamics	
Contents	No of hours
Unit I Governing Equations and Boundary Conditions: Basics of computational fluid dynamics, Governing equations of fluid dynamics – Continuity, Momentum and Energy equations, Chemical species transport –Physical boundary conditions, Time-averaged equations for Turbulent Flow, Turbulent–Kinetic Energy Equations, Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations.	07
Unit II Finite Difference Method: Derivation of finite difference equations, Simple Methods, General Methods for first and second order accuracy, solution methods for finite difference equations, Elliptic equations ,Iterative solution Methods , Parabolic equations , Explicit and Implicit schemes , Example/ Problems on elliptic and parabolic equations.	07

Unit III Finite Volume Method (FVM) For Diffusion: Finite volume formulation for steady state One, Two and Three -dimensional diffusion problems. One dimensional unsteady heat conduction through Explicit, Crank –Nicolson and fully implicit schemes.	07
Unit IV Finite Volume Method For Convection Diffusion: Steady one-dimensional convection and diffusion, Central, upwind differencing schemes-properties of discretization schemes, Conservativeness, Boundedness, Trasnportiveness, Hybrid, Power-law, QUICK Schemes.	07
Unit V Calculation Flow Field By FVM: Representation of the pressure gradient term and continuity equation –Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants. Turbulence models, mixing length model, Two equation (k-Є) models –High and low Reynolds number models.	08

References:

Text Books Recommended:

1. Computer Simulation of Flow and Heat Transfer, Ghoshdastidar , P. S., Tata McGraw Hill PublishingCompany Ltd.
2. An Introduction to Computational Fluid Dynamics, The finite volume Method, Versteeg, H. K., & Malalasekera, W., Pearson Education. Ltd.

Reference Books Recommended:

1. Numerical Heat Transfer and Fluid Flow, Patankar, S.V., Hemisphere Publishing Corporation.
2. Computational Fluid Flow and Heat Transfer, Muralidhar, K. Sundararajan T, Narosa PublishingHouse, New Delhi

RTM Nagpur University-Mechanical Engineering
B.Tech. 7th Semester
Elective – III: Computational Fluid Dynamics Lab (BTME701P)
Syllabus (Practical)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
VII	Computational Fluid Dynamics	-	-	2	1	25	25	50

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Explain the fundamentals of fluid flow and thermal simulations.
CO2	Select different boundary conditions, mesh generation techniques to simulate fluid flow and thermal problem.
CO3	Solve fluid flow and thermal analysis problems using commercial software package for different geometry and configurations.
CO4	To analyze the results obtained using postprocessing to make meaningful inferences.

List of Practical

Sr. No.	List of Practical
01	Flow Analysis over an Airfoil.
02	Investigate the convective heat transfer characteristics inside a pipe with a known fluid flow rate and temperature difference.
03	Study the flow behavior and pressure distribution in a convergent-divergent nozzle to understand the principles of supersonic flow.
04	Simulate the flow around a cylinder and examine the formation of vortex shedding and its effects on drag and lift forces.
05	Evaluate the mixing performance and residence time distribution in a stirred tank reactor under different impeller configurations and rotational speeds.
06	Simulate the aerodynamic behavior of a simplified car model to analyze drag and lift forces, and identify regions of flow separation.
07	Investigate the heat transfer characteristics and flow patterns in a rectangular enclosure with differentially heated walls, considering natural convection.
08	Analyze the flow rate measurement accuracy of a venturimeter by evaluating the pressure drop across the device and correlating it with the known flow rates.
09	Study the pressure drop and flow characteristics in a pipe bend to analyze the effects of curvature and investigate secondary flow patterns.
10	Analyze the heat transfer performance and effectiveness of a finned heat exchanger design by considering various fin geometries and flow rates.

RTM Nagpur University-Mechanical Engineering
B.Tech. 7th Semester
Energy Conversion III (BTME702T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Exami	Total	
VII	Energy Conversion-III	3	0	0	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	This course is designed to learn and understand the gas turbine and jet propulsion systems and its applications. Also, provides the fundamental knowledge of other non-conventional energy sources.
2	It will help the students to analyze the gas turbine and jet propulsion system based on varied operating conditions.
3	To impart the knowledge and develop the logic to prepare the hydraulic and pneumatic circuits according to industrial requirements.
4	It provides a basic knowledge of solar energy and its application.
5	It aims to generate the interest in thermal power systems.
Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Students will be able to analyze the gas turbine and jet propulsion system on varied operating conditions.
CO2	Students will be able to recognize the hydraulic pumps and valves and can able to logically design the hydraulic circuit.
CO3	Students will be able to recognize the air compressors and pneumatic control valves and can able to logically design the pneumatic circuit.
CO4	Students will be able to understand solar power and future opportunities in solar power systems.
CO5	Students will learn the basics of various non-conventional energy sources and their applications.

SYLLABUS- Energy Conversion-III	
Contents	No of hours
Unit I **Gas Turbine**: Introduction to Gas Turbine, Classification of Gas turbine, Open cycle and closed cycle gas turbine, effect of inter-cooling, reheating & regeneration, fuel-air ratio, combustion efficiency, performance calculation. (Analytical treatment needed) Jet Propulsion: Principles & working of turbojet, turbo-prop, Ramjet & pulse jet, simple turbojet cycle. (No Analytical Treatment)	07
Unit II **Hydraulic systems:** Hydraulic systems: Introduction, essential elements of a hydraulic system: Pumps, actuators, directional control valves, pressure control valves, flow control valves, accumulators. Basic hydraulic circuits - Meter in & Meter out, Bleed off, Regenerative, Pressing and Parallel circuit.	07
Unit III **Pneumatic systems:** Principle of pneumatics, comparison with hydraulic power transmission. Study of various Compressors used in pneumatic system, air preparatory unit, pneumatic valves (Seat type and Spool type valve, Time delay valve, Quick exhaust valve and Twin Pressure valve), Various Pneumatic circuits.	07
Unit IV **Solar Energy:** Introduction, solar constant, spectral distribution of solar radiation, Solar radiation geometry, solar angles, estimation of average solar radiation, radiation on tilted surface, tilt factors. (Analytical treatment needed) Principle of solar energy collection, flat plate & concentrating collectors for water and air heating, solar energy storage, solar pond, application of solar energy for cooking, drying, solar photovoltaic system & its applications.	07
Unit V **Non-Conventional Energy sources**: Introduction to wind energy, Working of wind generators & MHD generator, Introduction to fuel cell. Introduction to Biomass and Ocean energy, open and closed cycle of OTEC, Geothermal and tidal energy. Applications of non-conventional energy.	07

References:

Text Books Recommended:

6. Non-Conventional Energy Storage, Rai G.D., Khanna publication.
7. Industrial Hydraulics, John J. Pippenger, Tata McGraw Hill.
8. Pneumatic Systems, S. R. Mujumdar, Tata McGraw Hill.
9. Thermal Engineering, R. K. Rajpput, Laxmi Publications.

Reference Books Recommended:

1. Solar Energy Fundamentals and Applications, Garg, H.P., Prakash J., Tata McGraw Hill.
2. Gas Turbine& Jet Propulsion, Dubey & Khajuriya, Dhanpat Rai & Sons.
3. Renewable Energy Sources and Emerging Tech., Kothari. PHI.
4. Industrials of Hydraulic and pneumatic systems by Sameer Sheikh.

RTM Nagpur University-Mechanical Engineering
B.Tech. 7th Semester
Open Elective – II: Introduction to Electric Vehicles (BTME703T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Exami	Total	
VII	Introduction to ElectricVehicles	3	-	-	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	To Understand the basic principles, operation, various components and technology pertaining to Electric Vehicles.
2	To learn working of Electric Vehicle and influence of various components on performance of an EV.
3	To deliver and discuss the about architecture, vehicle dynamics, drive control systems, energy management systems of an electric vehicle

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Explain the basics of electric vehicles, their architecture, technologies and fundamentals
CO2	Interpret the working of different electrical equipment in electric vehicles
CO3	Explain the use of different energy storage systems used electric vehicles, their control techniques.
CO4	Understand the control and configurations of EV charging stations and know how of various energy management strategies
CO5	Outline the policies and regulations for electric vehicles in global and Indian scenario

Syllabus Open Elective – II: Introduction to Electric Vehicles	
Contents	No of hours
Unit I History of Automobiles, Constructional features of different types of engines used in automobiles, Introduction of Electric Vehicles, types of Electric Vehicles, Components of Electric Vehicle, Comparison with Internal combustion Engine: Technology, Benefits and Challenges, EV classification and their electrification levels.	07

Unit II Layout of chassis and main components of vehicles, Constructional aspects of Electric Vehicles. Basic concept of electric traction, introduction to various electric drive- train topologies. Electric Drive and controller: Principle and working of DC Motor Characteristics and types of DC Motors, Overview (Speed Torque Characteristics) of permanent magnet motor, BLDC motor, Induction motor. Comparison of all motors.	08
Unit III Introduction to energy storage requirements in electric vehicles, battery-based energy storage and its analysis, Fuel cell-based energy storage and its analysis, Hybridization of different energy storage devices. Energy storage systems used; Battery electrochemistry, battery design and construction, charging and discharging, power density, Battery interfaces with motive sources.	08
Unit IV Introduction to energy management strategies used electric vehicles, classification of different energy management strategies and comparison of different energy management strategies. : EV Charging Technologies: Classification of different charging technology for EV charging station, introduction to Grid-to-Vehicle, Vehicle to Grid (V2G) or Vehicle to Buildings (V2B) or Vehicle to Home (V2H) operations.	08
Unit V Indian & Global Scenarios in Electric Vehicles: Technology Scenario, Market Scenario, Policies & Regulations, Payback & Commercial Model, Policies in India.	05

References:

Text Books Recommended:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003

Reference Books Recommended:

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, 2004.
2. Chris Mi, M. Abul Masrur, David Wenzhong Gao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, John Wiley & Sons Ltd. , 2011

RTM Nagpur University-Mechanical Engineering
B.Tech. 7th Semester
Open Elective – II: Waste management (BTME703T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Exami	Total	
VII	Waste management	3			3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	To protect health, well being and environment through effective **waste management** techniques.
2	To minimize the production of **waste** and to prevent pollution .
3	to reduce and reuse of **waste**
4	safe **disposal** of **waste**

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Understand different aspects of solid waste, its sources and effects on man and material etc.
CO2	Understand problems arriving in handling large amount of solid waste generated ,its collection and transportation, processing and will able able to design safe collection and disposal methods
CO3	Design methods and equipments for solid waste management to reduce its impact on environment.
CO4	Evaluate and Analyze hazardous waste.
CO5	Design the appropriate disposal systems for hazardous wastes management.

SYLLABUS	
Contents	No of hours
Unit I solid waste: Definition of solid wastes – types of solid wastes – Sources - Industrial, mining, agricultural and domestic – Characteristics. Solid waste Problems - impact on environmental health – Concepts of waste reduction, recycling and reuse. Waste characteristics, generation, collection, transport and disposal. ,	8
Unit IICOLLECTION, SEGREGATION AND TRANSPORT OF MUNICIPALSOLID WASTES: Handling and segregation of wastes at source. Collection and storage of municipal solid wastes; analysis of Collection systems. Transfer stations – labeling and handling of hazardous wastes. ,	7

UNIT III MUNICIPAL SOLID WASTE MANAGEMENT : Solid waste processing technologies. Mechanical and thermal volume reduction. Biological and chemical techniques for energy and other resource recovery: composting, vermicomposting, termigradation, fermentation .Regulatory aspects Of municipal solid waste management. ,	8
UNIT IV HAZARDOUS WASTES: Hazardous waste definition. Physical and biological routes of transport of hazardous substances – sources and characterization categories and control. Sampling and analysis of hazardous wastes – analytical approach for hazardous waste characterization – proximate analysis – survey ,	7
UNIT V HAZARDOUS WASTES MANAGEMENT: Sources and characteristics: handling, collection, storage and transport, TSDF concept. Hazardous waste treatment technologies - Physical, chemical and thermal treatment of hazardous waste. Radioactive waste: Definition, Sources, Low level and high level radioactive wastes and their management. ,	8

References:

Text Books Recommended:

1. Hazardous waste management Charles A. Wentz. Second edition 1995. McGraw Hill International.
2. Integrated solid waste management George Tchobanoglous, Hilary Theisen & Sammuel A. Vigil.
3. Hazardous waste management by Prof. Anjaneyulu.
4. Biomedical waste management by Dr Vishal Bathma.
.

Reference Books Recommended:

1. Environmental Sciences by Daniel B. Botkin and Edward A. Keller, Wiley student, 6th edition- 2009.
2. Standard handbook of Hazardous waste treatment and disposal by Harry M. Freeman, McGraw Hill 1997.

RTM Nagpur University-Mechanical Engineering
B.Tech. 7th Semester
Open Elective – II: Finance and Cost Management (BTME703T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Exami	Total	
VII	Finance and Cost Management	3			3	30	70	100	3

Sr. No.	Course Objectives The objective of this course is–
1	To understand the concept of finance & cost management; various sources of generating the finance and to understand the books of account & also about recent trends in management.
2	To do break even analysis, decide equipment replacement policy, and take make or buy decision.
3	Ability to appreciate the importance of cost and management accounting, Understand the applicability of cash flow statement in business.
Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	apply the knowledge of basics of Financial Management concepts and Time Value of Money
CO2	select, classify, analyze and plan the sources of finance, types of capital, various elements of costs, cost control and evaluate equipment replacement policy, make or buy decisions.
CO3	develop and interpret books of Accounts, Trial Balance, balance Sheet, P&L account, cash flow statement in business
CO4	evaluate and examine various Cost of Capital, opportunity cost of capital, Cost of different sources of finance
CO5	evaluate, select and determine various techniques of capital budgeting, profitability index.

SYLLABUS	
Contents	No of hours
Unit I Introduction To Financial Management - Concept of business finance, finance function, scope, organization, Goals & objectives of financial management, Time Value of Money	7
Unit II Financial management: Sources of finance, financing organizations, types of capital, elements of costs & allocation of indirect expenses, cost control, break even analysis, equipment replacement policy, make or buy analysis	8
Unit III. Recording of transactions: Accounting Process, Journals, Cash Book, Ledger and Preparation of Trial Balance, Balance sheet, Profit & loss statement.	7
Unit IV: Cost of Capital - Concept, meaning, principles & importance, Opportunity Cost of capital, Cost of different sources of finance, weighted average cost of capital & factors affecting cost of capital.	8

Unit V Investment Decision - Capital budgeting - Nature and significance, techniques of capital budgeting- Pay Back Method, Accounting rate of return, Internal Rate of Return, Net Present Value and profitability index.	8

References:

Text Books Recommended:

1. Financial Management, Kuchal S.C, Chaitanya Publishing House.
2. Financial Management by R. P. Rustagi, Taxmann's Publication
3. FinancialManagementbyDr.P.C.Tulsian,S.Chand
4. FinancialManagementPrinciplesandPracticebyG.SudarsanaReddy,HimalayaPublishingHouse
5. ManagementAccounting10thEdition:M.N.Arora

Reference Books Recommended:

1. ManagementAccountingPrinciples&Practice:SharmaR.K.&GuptaS.K.
2. CostAccountingPrinciples&Practice:JainNarang,PHI.
3. Financial,CostandManagementAccounting,Dr.P.Periasamy,2ndEdition,HimalayaPublishingHouse.

RTM Nagpur University-Mechanical Engineering
B.Tech. 7th Semester
Open Elective – II: Industrial Robotics (BTME703T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Exami	Total	
VII	Industrial Robotics	03	-	--	03	30	70	100	03

Sr. No.	Course Objective The objective of this course is–
1	To introduce the functional elements of Robotics.
2	To impart knowledge on the direct and inverse kinematics.
3	To introduce the dynamics and control of manipulators.
4	Ability to understand basic concept of robotics sensors and to know about the dynamics and control in robotics industries
Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Understand history and classification of robots
CO2	To know about robot end effectors and grippers
CO3	Understand direct and inverse kinematics
CO4	Understand the types of robot sensors and its applications
CO5	To know the cell layouts of robots and its interface

SYLLABUS	
Contents	No of hours
Unit I Basic concepts**:** - Brief history-Types of Robot–Technology-Robot classifications and specifications- Design and controlissues- Various manipulators – Sensors - work cell - Programming languages. ,	07
Unit II Robots end-effectors-classification of end-effectors, mechanical grippers, hooking or lifting grippers, grippers for molten metal's, plastics, vacuum cups, magnetic grippers, electrostatic grippers, multiple grippers, internal & external grippers, drive systems for gripers, active & passive grippers. ,	07

Unit III Direct and inverse kinematics :- Mathematical representation of Robots - Position and orientation – Homogeneous transformation Various joints- Representation using the Denavit Hattenberg parameters - Degrees of freedom-Direct kinematics-Inverse kinematics- SCARA robots- Solvability – Solution methods-Closed form solution. ,	08
Unit IV Robot Sensors: Scheme of robotic sensors, contact type sensors, force, torque, touch, position, velocity sensors, non-contact type sensors, electro-optical imaging sensors, proximity sensors, range imaging sensors, robot environment and robot input/output interfaces, machine intelligence, safety measures in robots. ,	07
Unit V Robot cell layouts, multiple robots and machine interface, other considerations in work cell design, work cell control, interlocks, error detection and recovery, Quantitative Techniques for economic performance of robots: Robot investment coats, robot operating expenses. General considerations in robot material handling, material transfer applications, pick and place operations, machine loading and unloading, die casting, plastic molding, forging, machining operations, stamping press operations using robots. ,	08

References:

Text Books Recommended:

1. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint, 2005.

2. JohnJ.Craig ,Introduction to Robotics Mechanics and Control, Third edition, Pearson Education
3. M.P.Groover, M.Weiss, R.N. Nageland N. G.Odrej, Industrial Robotics, McGraw-Hill Singapore, 1996.

Reference Books Recommended:

1. Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis', Oxford University Press, Sixth impression, 2010.
2. K. K.Appu Kuttan, Robotics, I K International, 2007.
3. Edwin Wise, Applied Robotics, Cengage Learning, 2003.
4. R.D.Klafter,T.A.Chimielewski and M.Negin, Robotic Engineering–An Integrated Approach, Prentice Hall of India, New Delhi, 1994.
5. B.K.Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers,Chennai, 1998.
6. S.Ghoshal, " Embedded Systems & Robotics" – Projects using the 8051 Microcontroller", Cengage Learning, 2009.

RTM Nagpur University-Mechanical Engineering
B.Tech. 7th Semester
Open Elective – II: Introduction to Renewable Energy Resources (BEME703T)
Syllabus (Theory)

Semester	Course Title(Subject)	Hours /Week			Credits	Maximum Marks			ExamDuration (Hrs.)
		L	T	P		Continual Assessment	University Examine	Total	
VII	Introduction to Renewable Energy Resources	3	-	-	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1.	To make the students conversant with the non-conventional energy resources, its need, and their utilization to harness the power.
2.	The students will learn the solar energy utilization with its applications.
3.	The students will understand the various methods by which energy can be generated from wind, ocean tides, Fuel Cell, Geothermal phenomenon, Biogas and MHD

Course Outcomes

At the end of the course students will be able to

CO1	Recognize the need of renewable energy sources.
CO2	Understand various solar thermal energy conversion systems and solar photovoltaic systems in detail.
CO3	Describe different biogas plants, bio-diesel production method and potential of hydrogen as a fuel.
CO4	Explain the working principle of Wind energy systems and ocean thermal energy conversion systems
CO5	Describe the working of Fuel cell system, Geothermal &Magneto hydro dynamic (MHD) power generation systems and Understand the principles of energy conservation.

Syllabus Open Elective – II: Introduction to Renewable Energy Resources

Contents	No of hours
Unit I Global energy scenario, Indian energy scenario, Environmental aspects of energy utilization, conventional and non-conventional sources of energy, merits, and challenges, Solar Energy: Introduction, solar constant, spectral distribution of solar radiation, beam & diffuse radiation, advantages of solar energy **Solar electrical energy conversion:** Construction and working of solar cells and PV modules, different PV technologies, Photovoltaic system components and different applications	07
Unit II **Solar Thermal Energy Conversion:** Solar flat plate collectors: Types of collectors, liquid flat plate collectors, solar air heaters, Concentric collectors: line focusing, point focusing and non-focusing type, central receiver concept of power generations, compound parabolic collector, comparison of flat & concentric collectors. Solar Ponds, Solar Cookers, Solar energy storage, sensible, latent and thermochemical storage,	07

Unit III **Energy from Biogas**: - Introduction, bio gas generation, fixed dome & floating drum biogas plants, their constructional details, raw material for biogas production, factors affecting generation of biogas, digester design considerations, fuel properties of biogas and utilization of biogas. Bio Mass: Introduction, methods of obtaining energy from biomass, thermal gasification. **Biodiesel:** Types of biodiesel, Trans-esterification process, Properties and application	08
Unit IV **Wind Energy**: Wind characteristics and site selection, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, Wind energy conversion systems; Types of WECS and their characteristics, components, Working of horizontal and vertical axis wind turbine machines, **Ocean Energy**: Tidal power plants: single basin and two basis plants, Variation in generation level ; Ocean Thermal Electricity Conversion (OTEC) ; Electricity generation from Waves : Shoreline and Floating wave systems.	08
Unit V **Hydrogen Energy:** Properties of Hydrogen with respect to its utilization as a renewable form of energy, sources of hydrogen, production of hydrogen, electrolysis of water **Fuel Cell Technology**: Introduction, Principle of working, Types of fuel cells, Fuel cell efficiency **Geothermal energy**: Introduction, classification of geothermal systems, vapour dominated, liquid dominated system, petrothermal systems, magma resources, applications of geothermal energy.	06

References

Text Books Recommended:

1. Non-Conventional Energy Sources, G.D. Rai, Khanna publishers.

2. Non-Conventional Energy Resources: B.H. Khan, Tata McGraw Hill.

3. Solar Energy Utilization, G.D. Rai. Khannapulishers.

4. Industrial Energy Conservation, D. A. Ray, Pergaman press.

Reference Books Recommended:

1. Renewable Energy Sources and Emerging Tech., Kothari. PHI.

2. Solar Energy, S.P. Shukhatme, Tata McGraw Hill Education.

3. Renewable Energy Recourses: Basic Principle and Applications: G.N. Tiwari andM.K. Ghosal, Narosa publication.

RTM Nagpur University-Mechanical Engineering
B.Tech. 7th Semester
Design of Transmission Systems (BTME704T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Exami	Total	
VII	Design of Transmission Systems	3	1	-	4	30	70	100	3Hours

Sr. No.	Course Objective The objective of this course is–
1	To make students conversant with basic design principles of transmission systems like gears, belts, chains, ropes along with other associated rotating components like different types of bearings and flywheel.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Design journal and thrust bearings and selection of standard rolling contact bearings.
CO2	Design flexible transmission drives like belts, chains and rope
CO3	Design the positive transmission drives like gears as spur and Helical Gear.
CO4	Design the positive transmission drives like gears as worm and Bevel Gears
CO5	Design the energy storing components like Flywheels for various applications.

SYLLABUS	
Contents	No of hours
Unit I Rolling Contact Bearing Types of rolling contact bearings, Static and dynamic load carrying capacities, Stribeck's Equation, Equivalent bearing load, Load- life relationship, Selection of bearing life, Selection of rolling contact bearings from manufacturer's catalogues, Selection of bearing for cyclic loads and speeds- bearing with probability of survival other than 90% Sliding Contact Bearing: Introduction of sliding contact Bearing, Classification of sliding contact bearing, Hydrodynamic Lubrication: Theory of Hydrodynamic Lubrication, Pressure Development in oil film, 2DBasic Reynolds Equation, Somerfield number, Raimondi and Boyd method, Thermal considerations, Parameters of design of journal and thrust bearings.	8 Hrs
Unit II Belt, & Wire Rope Design of Flat belt drive: Types of belts & belt material, analysis of belt tension, condition for transmitting maximum power, design of flat belt, flat belt pulley. Design of V belt drive: Types of V-belt, analysis of V-belt tension, design of V belt & pulley. Introduction to synchronous belt drive design (Toothed pulleys and belts) Design of wire rope drive: Introduction to wire rope, stresses in hoisting wire rope. Design of wire rope, sheave and drum.	7Hrs
Unit III Spur Gears and Helical Gears: Design of Spur Gear Drive: Gear Selection, material selection, Basic modes of tooth failure, Gear Lubrication Methods, Number of teeth and face width, Force analysis, Beam strength (Lewis) equation, Velocity factor, Service factor, Load concentration factor, Effective load on gear, Wear strength (Buckingham's) equation, Estimation of module based on beam and wear strength, Estimation of dynamic tooth load by velocity factor and Buckingham's equation. Design Helical Gears: Types of helical, Terminology, Virtual number of teeth, and force analysis of Helical Gear. Design of Helical drive.	7 Hrs
Unit IV Worm Gears and Bevel Gear: Design of Worm Gear Drive: Worm Gearing—AGMA Equation; Worm-Gear force analysis Designing a Worm-Gear Mesh; Buckingham Wear Load. Design of Bevel Gear Drive: Types of Bevel gear, proportions of bevel gears, force analysis of bevel gear drive, design of straight bevel gear drive.	7Hrs
Unit V Flywheel: Design of Flywheel: Functions, Coefficient of fluctuation of energy and Coefficient of fluctuation of speed, energy storage in flywheel, stresses in flywheel, design of flywheel Design of Roller chain drive: Velocity ratio and length of chain, design of chain, dimensions of tooth profile, design of sprocket.	7Hrs

Sr. No.	List of Tutorials
01	Numerical on Rolling contact and sliding contact bearing
02	Numerical on Belt Drive, Chain Drive and Wire rope
03	Numerical on Spur, Helical and Bevel gear
04	Numerical on Worm gear and Flywheel

References:

Text Books Recommended:

1. Design of Machine Elements, B.D. Shiwalkar. Central Techno publications
2. Design of Machine Elements, V. B. Bhandari., McGraw Hill education.
3. Design of Machine Elements, Sharma &Purohit, PHI.
4. Design Data book, B.D. Shiwalkar, Central Techno publications.
5. Mechanical Engg. Design, Shigley, TMH.
6. Design Data Book, PSG.

Reference Books Recommended:

1. Mechanical Design Analysis, M. F. Spotts, Prentice-Hall.
2. Machine Component Design, Robert C. Juvinall, Kurt M. Marshele, Wiley.
3. Machine Design, Maleev& Hartman, CBS publishers.
4. Hand book of Machine Design, Shigley&Mischke, McGraw Hill.
5. Machine Design, Robert L.Norton, Pearson.
6. The Principles of Design ,Nam P. Suh, McGraw Hill
7. Manufacturer's handbook of belts, pulleys, chains, bearings, etc.

RTM Nagpur University-Mechanical Engineering
B.Tech. 7th Semester
Summer Internship (BTME705P)

Summer Internship should be undertaken after end of 6th Semester for a minimum duration of 4 weeks in Industry/ Research Institute/ Organizations & its Evaluation to be done in 7th semester

RTM Nagpur University-Mechanical Engineering
B.Tech. 7th Semester
Project Phase I (BTME706P)

Sr. No.	Course Outcomes
After successful completion of this course the student will be able to:	
CO1	Convert their conceptual ideas into working projects .
CO2	Explore the possibility of publishing papers in journal.
CO3	Enhance their knowledge through an on-line collection of evidence, work and other information.
CO4	Ultimately promotes for inter-personal communication, punctuality, demonstration of appropriate written and oral communication skills with overall Work-Integrated-Learning.
CO5	Develop an understanding of social, cultural, professional, ethical, global and environmental responsibilities of the professional Engineer.

A load of 2 hours/week per project guide for the course "Project Phase I"

RTM Nagpur University-Mechanical Engineering
B.Tech. 7th Semester
Employability Enhancement (BTME707P)

Students should be given training on

1.Technical aptitude

2.General aptitude

3.Group Discussion

4.Interview Techniques

To enhance their chances of employment.

Students should be given training on Technical aptitude, General aptitude, Group Discussion, Interview Techniques to enhance their chances of employment

RTM Nagpur University-Mechanical Engineering
B.Tech. 8th Semester
Industrial Engineering (BTME801T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assess	University Exami	Total	
VIII	Industrial Engineering	3	0	0	3	30	70	100	03

Sr. No.	Course Objective The objective of this course is–
1	To understand and analyze the concept of productivity and work measurement.
2	To develop the ergonomics system for better productivity.
3	To develop break even analysis and demand forecasting.
Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Understanding the concept of productivity and method study.
CO2	Ability to measure work time and design ergonomic system.
CO3	To understand the concept of forecasting and breakeven analysis.
CO4	To analysis maintenance and reliability of equipments.
CO5	To understand various quality control tools and techniques.

SYLLABUS	
Contents	No of hours
Unit I **Work Study:** Productivity – Concept and objectives of productivity, Types of productivity, factors affecting productivity. Tools and techniques to improve productivity, Measurement of productivity. **Work study** and methods study : Definitions, objectives, steps in method study, process charts, string diagram, motion study, micro motion study, SIMO Chart. ,	08 Hrs

Unit II **Work measurement :** Objectives, definition, stop watch study, work sampling , PMTs, MTM & Work factor method. **Ergonomics** : Objectives, Human factors in Engg., Man machine system, Display design, design controls. Principles of motion economy, work place design. ,	08Hrs
Unit III **Forecasting:** Need for forecasting, classification of forecasting methods, like judgmental technique, time series analysis, least square method, moving average method, exponential smoothing method. **Break Even analysis:** classification of costs, analysis of production costs, Break – even analysis. ,	07 Hrs
Unit IV **Maintenance:** Objectives, Types of maintenance, preventive, predictive, break down maintenance **Reliability** and maintainability analysis Failure data analysis, reliability, MTBT, MTTR, Batch tub curve, series parallel and stand by system. ,	07 Hrs
Unit V **Quality Control:** Definition, function, objective characteristics. Quality, Quality of design quality of conformance, process control charts and process capability. **Quality Control tools:**Quality assurance & quality Planning, Quality audit, Vendor quality rating, Acceptance sampling, concept and significance, Type of sampling, sampling plan, OC curve. ,	08 Hrs

References:

Text Books Recommended:

1. Martand Telsang, Industrial Engineering & Production Management & S. Chand &co.
2. Maynard H.B.: Industrial Engineering Handbook, Mc Graw.Hill
3. Work study by ILO
4. Industrial Engg. & Management by Vishwanath, SciTech Publication
5. Industrial Engg. Management, N.V.S. Raju, Cengage Publication
6. Statistical Quality Control by E. Grant, McGraw Hill, R. S. Leavenwarth

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Reference Books Recommended:

1. Total Quality Management: Dale H. Besterfield, Carol Besterfield - Michnaetal, Pearson.
2. ShridharaBhat K, Total Quality Management – Text and Cases, Himalaya Publishing House

RTM Nagpur University-Mechanical Engineering
B.Tech. 8th Semester
Elective – IV: Finite Element Method (BTME802T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
VIII	Finite Element Method (El-IV ME)	3			3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	To teach the fundamentals of finite element method with emphasize on the underlying theory and assumption
2	To develop theoretical foundations and appropriate use of finite element methods
3	To provide hands on experience using finite element software to model, analyze and design systems
4	To inculcate programming knowledge of generating algorithms.
Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Understand the application of fundamentals of solid mechanics for evaluation of structural problems for evaluation of Point load, body force, traction and torsional loads.
CO2	Analyze the application and formulation of the basic finite elements for static and truss.
CO3	Analyze the beam subjected to transverse loading condition.

CO4	Apply the mathematical models for the solution of common engineering problems using finite element methods i.e., formulation of simple & complex problems using finite elements and to develop the ability to generate the governing finite element equations for systems regulated by partial differential equations.
CO5	Remember the significance and difference between the formulation and application of thermal engineering problems using 1D & 2D finite elements.

SYLLABUS	
Contents	No of hours
Unit I Introduction Theoretical background - Brief History of FEM, General FEM procedure, Applications of FEM in various fields, Advantages and disadvantages of FEM. Finite element modeling - Node, Element, different types of element – spring, bar, truss, beam, frame, plane stress/strain (CST element) and axisymmetric elements, Coordinate systems – global, local and natural coordinate systems, Order of element, internal and external node(s), Degrees of freedom, field and dependent variables. Shape functions – linear, quadratic and cubic, properties of shape functions. Assembly of global stiffness matrix and load vector, Properties of stiffness matrix, Boundary conditions – elimination method and penalty approach. Calculation of elemental stiffness matrix and load vector (mechanical and thermal load) using energy method Stress calculations. FE Problems on Solid mechanics 1D bar element, composite element, self-weight, torsion. ,	**8**
Unit II FEM for Plane Truss,Introduction, Plane truss formulation of stiffness matrix for truss, problem on truss.	**7**

Unit III FEM for Beams – Introduction, element formulation, load vector, boundary conditions, shear force and bending moment, Beam on elastic support, problem on beam. Applications to bars stepped bars and beams for axial, transverse and torsional loading of the shaft.	**7**
Unit IV 2D CST Element and Isoparametric Elements and Formulations CST ELEMENT - Coordinate mapping Global and local coordinates. Formulation of stiffness matrix, load vector. ISOPARAMETRIC ELEMENTS - Isoparametric formulation, coordinate transformation, super parametric and sub parametric. The uniqueness of mapping - Jacobian matrix. Formulation of element equations (stiffness matrix and load vector). Numerical integration. FE Discretization - Higher-order elements vs. refined mesh (p vs h refinements). [Theoretical treatment only]	**7**
Unit V Introduction, steady-state heat transfer – 1D and 2D heat conduction and convection Governing differential equation, boundary conditions, formulation of an element. 1D Thermal Load problem using the coefficient of Thermal expansion, Steady State Heat Transfer, Computer Implementation of Finite Element Method Steady-State Heat Transfer Problems. Axisymmetric Introduction, shape function and numerical treatment. ,	**7**

References:

Text Books Recommended:

1. Introduction to Finite Elements in Engineering, Chandrupatla T. R. and Belegunda A. D., Prentice Hall.
2. Finite Element Analysis, Bhavikatti S. S., New Age International Publishers
3. Textbook of Finite Element Analysis, ChanakasavaAlavala, PHI Learning Private Ltd
4. Finite Element Method with Application in Engineering, Y.M.Desai, T.I.Eldho, A.H. Shah, Pearson publication.
5. First Course in the Finite Element Method, Daryl Logan, Cengage Learning,

6. An Introduction to the Finite Element Method, J. N. Reddy, McGraw Hill.
7. The Finite Element Method in Engineering, S. S. Rao, Butterworth-Heinemann.
8. Textbook of Finite Element Analysis, Seshu P., PHI Learning.

Reference Books Recommended:

1. Finite Element Procedures, Bathe K. J., Prentice-Hall of India.
2. Finite Element Analysis, Theory, and Practice, Fagan M. J., Pearson Education Limited.
3. Finite Element Modeling for Stress Analysis, Cook R. D., John Wiley and Sons Inc.
4. Kwon Y. W., Bang H., Finite Element Method using MATLAB, CRC Press.
5. Finite Element Analysis, Theory, and Application with Ansys, S. Moaveni, Pearson.
6. Fundamental Finite Element Analysis and Applications, AsgharBhatti, John Wiley and Sons Inc.
7. Fundamentals of Finite Element Analysis, David V. Hutton, Tata McGraw Hill Education Pvt. Ltd.
8. The Finite Element Method, Zienkiewicz O. C., Taylor R. I., ButterworthHeinemann.
9. Finite Element Application, G. Lakshmi Narasaiah, BS Publications.
10. Practical Finite Element Analysis, Gokhale N. S., Deshpande S. S., Bedekar S. V. and Thite A. N, Finite to Infinite, Pune.
11. Introduction to Finite Elements Method, Desai, and Abel, CBS Publication.
12. Introduction to Finite Element Analysis Using MATLAB® and Abaqus, Amar Khennane, CRC press.

RTM Nagpur University-Mechanical Engineering
B.Tech. 8th Semester
Elective – IV: Finite Element Method (BTME802P)
Syllabus (Practical)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
VII	Finite Element Methods	0	0	2				

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Analyze the finite element problems using commercial software and understand the fundamental use of finite element preprocessor, solver and post-processor.
CO2	Demonstrate the ability to evaluate and interpret Finite Element Analysis results for the design and evaluation of 1D and 2D finite element formulations.
CO3	Understand the Finite Element Modeling aspects of the Frequency response problem for solving engineering design problems.

List of Practical

LIST OF PRACTICALS: Minimum Six Practical's on the standard CAE packages like HYPERWORKS, ANSYS, NASTRAN, ABAQUS, or any other relevant software or freeware.

Sr. No.	List of Practical
01	Static structural analysis of Axially loaded bar with 1-D finite elements using standard FEA package.

02	Static structural analysis of bar under the influence of self-weight using 1-D finite elements using standard FEA package
03	Static structural analysis of bar under applied torque using 1-D finite elements using standard FEA package.
04	Static structural analysis of 1D truss using standard FEA package
05	Static structural analysis with 2-D Plate (CST) element using standard FEA package.
06	Static structural analysis of a beam under transverse loading using standard FEA package.
07	Dynamic structural analysis to determine natural frequency and mode shapes, using standard FEA package.
08	Thermal analysis to estimate nodal temperatures using standard FEA package.
09	Post-processing techniques used in commercial solvers like Radioss, Optistruct, Ansys.

RTM Nagpur University-Mechanical Engineering
B.Tech. 8th Semester
Elective – IV: Computer Integrated Manufacturing (BTME802T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assess	University Exami	Total	
VIII	Computer Integrated Manufacturing	3	0	0	3	30	70	100	3Hrs

Sr. No.	Course Objective The objective of this course is–
1	Develop an understanding of modern manufacturing systems, and associated control systems, management technology, and evaluation techniques.
2	Develop an understanding of computer-integrated manufacturing (CIM) and its impact on productivity, product cost, and quality.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	To understand integration of business function with manufacturing planning and control.
CO2	To apply fundamentals of robotics or industrial applications.
CO3	To develop CNC programs for manufacturing applications.
CO4	To understand the process of Group technology for Flexible manufacturing system.
CO5	Get Acquainted With Automated Inspection (CAPP, CAQC, CMM) And Group Technology.

SYLLABUS	
Contents	No of hours
Unit I Concept of CIM: Introduction to CIM, Types of Manufacturing, CIM hardware and software, Elements of CIM, CIM Wheel,benefits, limitations, Difference between Automation and CIM. Agile manufacturing and concurrent Engineering ,	7Hrs

Unit II CIM database: Introduction, Database requirements of CIM, Database, Database management, Database Models, Product Data Management (PDM), Advantage of PDM. Introduction to NC, CNC & DNC, classification of CNC machine tools, CNC manual Part Programming ,	8Hrs
Unit III Introduction to Group Technology, Limitations of traditional manufacturing systems, characteristics and design of groups, benefits of GT and issues in GT. Part families, classification and coding, Production flow analysis, Machine cell design, Benefits. ,	8Hrs
Unit IV Manufacturing Planning: Process Planning in the Manufacturing cycle , Computer aided process planning (CAPP), Retrieval & Generative CAPP systems. Production Planning: Aggregate Production Planning, Master production schedule, Materials requirement planning(MRP), Capacity planning, Manufacturing Resources planning (MRP II), ERP. Manufacturing system control: Computerized statistical process control, Shop floor control, CAQC ,	7Hrs
Unit V Introduction to flexible manufacturing systems: Definition of FMS, Types of FMS: by number of machines, Level of Flexibility. FMS components: Workstations, Material handling & storage system, and computer control systems. FMS Layout Configurations. Application, advantages & disadvantage of FMS. ,	8Hrs

References:

Text Books Recommended:

1. Automation, production System & CIMS Third edition(2007)M P, Groover PHI Prentice-Hall of India Pvt. Ltd., New Delhi, 2002

2 Radhakrishnan P, Subramanyan S.and Raju V., "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi, 2000.

3 CAD/CAM Fifth edition (2008) Zimmers & GrooverPIll Pearson Education India

4 Systems Approach to Computer Integrated Design and Manufacturing1996 Nanua Singh Wiley & Sons, 1996.

5 Handbook of Flexible Manufacturing Systems1991 Jha, N.K Academic Press nc.,

6Group Technology in Engineering Industry 1979 Burbidge, J.L Mechanical Engineering pub. London,

Reference Books Recommended:

1.1Numerical Control And Computer Aided Manufacturing 13th edition (2007) Rao, N K Tiwari, T K Kundra Tata McGraw-Hill Education

2Computer Control of Manufacturing Systems 2005 Koren Mcgraw Hill

3G.T Planning and Operation, in The automated factory Hand Book: Technology and Management1991 Askin, R.G. and Vakharia, A.J Cleland, D.I. and Bidananda, B (Eds), TAB Books, NY, 1991.

4Cellular Manufacturing Systems Irani, S.A Hand Book

5Planning, design and analysis of cellular manufacturing systems 1995 Kamrani, A.K, Parsaei, H.R and Liles, D.H. (Eds)Elsevier

RTM Nagpur University-Mechanical Engineering
B.Tech. 8th Semester
Elective – IV: Computer Integrated Manufacturing (BTME802P)
Syllabus (Practical)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
VIII	Computer Integrated Manufacturing			2	1	25	25	50

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Ability to Recognize automation and CIM ,CIM wheel, hardware, software, components of CIM
CO2	The student will have ability to apply fundamentals of G.T and FMS
CO3	The student will have ability to apply fundamentals of CAPP and CAQC
CO4	The student will have ability to develop CNC programs for manufacturing applications.

List of Practical

{Minimum Eight out of the following shall be performed ,out of which four must be performance based}

Sr. No.	List of Practical
01	Introduction to CIM. (Product Development Cycle, CIM Wheel)
02	Introduction to NC. (Basic components, classification)
03	Simulation on CNC Lathe & CNC Milling (one program each)
04	Manual Part Programming – Lathe.
05	Manual Part Programming – Milling
06	Manual Part Programming by using Sub routine & Canned Cycles
07	Study of CAPP Systems. (Retrieval & Generative)
08	Part classification and Coding using G.T.
09	Study of F. M. S
10	Study of different quality measurement tools

Suggested References:

1. Computer Integrated Manufacturing Handbook, Eric Teicholz and Joel orr, McGraw Hill Book Co.
2. Computer Integrated Manufacturing, Paul G. Ranky, PHI.
3. CAD/CAM – theory & practice, Ibrahim Zeid, Tata McGraw Hill Publication.
4. Computer Aided Manufacturing, P.N. Rao, N.K. Tewari and T.K.Kundra, Tata McGraw Hill Publication.
5. Systems Approach to Computer Integrated Design and Manufacturing, Nanua Singh, John Wiley publication.
6. Computer Control of Manufacturing Systems, Yoram Koren, McGraw Hill publication.
7. Scolz B. Reiter C.I.M interfaces Chapman & Hall 1992 David L. Goetsch, fundamental of CIM technology, Delmer Publication 1988
8..Engelwood Cliffs NJ David Bedworth et.al Computer integrated design and manufacturing McGraw hill 1991

RTM Nagpur University-Mechanical Engineering
B.Tech. 8th Semester
Elective – IV: Refrigeration & Air-conditioning (BTME802T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Exami	Total	
VIII	Refrigeration & Air-conditioning	3	0	0	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	To know about refrigeration systems, its types various components.
2	To know about the analysis of refrigeration systems and compound refrigeration systems.
3	To know about psychometric processes and load calculation for heating and cooling.
4	To know about the design of HVAC system, types of AC and air handling units.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Understand the basics concepts of refrigeration, and Analyze refrigeration cycle and refrigerants.
CO2	Understand the concept of vapour absorption refrigeration, air refrigeration system and cryogenics.
CO3	Understand the concept of psychrometry and analyze heat load calculations.
CO4	Understand the concept of air- distribution and air handling units
CO5	Understand the design and selection of AC System. Control devices for air-conditioning systems.

SYLLABUS - Elective – IV: Refrigeration & Air-conditioning	
Contents	No of hours
Unit I Introduction, Concept and Development of Vapor Compression Refrigeration Cycle from Reverse Carnot Cycle, Effects of Super-heating and Sub-cooling, with analytical treatment. Refrigerant: Environmental Impact- Montreal, Kyoto protocols-Eco Friendly Refrigerants, alternatives to HCFCs, Secondary Refrigerants. Components of Refrigeration: Compressor- Types, performance, Characteristics; Types of Evaporators & Condensers and their functional aspects; Expansion Devices and their Behavior with fluctuating load, cycling controls. Air cycle refrigeration and its applications, Boot Strap cycle, Regenerative cycle, Reduce Ambient cycle.	08
Unit II Vapor Absorption Systems-Aqua Ammonia & Li-Br Systems, Steam Jet Refrigeration, Thermo-Electric Refrigeration, Vortex tube. Compound Refrigeration System, Multiple Compressor System, Multiple Evaporator System with analytical treatment.	07
Unit III Introduction to psychometric properties and processes of air. Classification of air conditioning systems, Applications of Psychometry to various air conditioning systems. Thermal comfort, Heat exchange between man and environment. Cooling and Heating Load calculations: Sources of heat gain/loss- Solar heat gain, heat gain through building structure, Indoor and Outdoor design conditions, Methods of heat load calculation, with analytical treatment.	08

Unit IV Room air distribution, Selection of supply and return grills and diffusers, types of air filters, static and dynamic losses in Ducts, Duct design methods, Duct friction chart, clean rooms. Types of fans, their characteristics and application. AC systems and controls: Types of AC systems – Unitary, Central – all air system, all water system, air- water system. VRF system, Chilled ceilings and chilled beams, displacement ventilation, two stage Evaporative cooling, Desiccant Dehumidification,	08
Unit V Air conditioning System Design: Design and selection of air conditioning systems and components for various applications – commercial building, supermarkets, hospital, restaurants, etc. Fluid flow and system controls – sensing devices, actuating elements, electric motors and controls, AC controls at partial load, Introduction to inverter and double inverter AC.	07

References:

Text Books Recommended:

1. Carrier Incorporation Handbook of Air Conditioning System Design, McGraw Hill, 1965.
2. Refrigeration and Air Conditioning, R.S.Khurmi, S.Chand and Company
3. Refrigeration and Air Conditioning, Arora and Domkundwar, DhanpatRai and Sons
4. Refrigeration and Air Conditioning, Arora C P, Tata McGraw Hill.
5. Refrigeration & Air conditioning, Stocker & Jones, McGraw Hill Publication.
6. Air conditioning and Refrigeration, Rex Milter, Mark R.Miller, McGraw Hill

Reference Books Recommended:

1. ISHRAE Handbooks (HVAC Handbook, HVAC Databook)
2. ASHRAE Handbooks (Refrigeration, HVAC Applications, HVAC Systems and Equipment, Fundamentals)

3. Dossat R.J., Principles of refrigeration, John Wiley , S.I. Version

4. Langley, Billy C., 'Solid state electronic controls for HVACR' pentice-Hall

5. Refrigeration and Air Conditioning, P.N. Ananthnarayan, Tata McGraw Hill.

RTM Nagpur University-Mechanical Engineering
B.Tech. 8th Semester
Elective – IV: Refrigeration & Air-conditioning (BTME802P)
Syllabus (Practical)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
VIII	**Elective-IV: Refrigeration & Air-conditioning**	**0**	**0**	**2**	**1**	**25**	**25**	**50**

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Evaluate the performance of vapour compression refrigeration systems.
CO2	Analyse the components of refrigeration system and Absorption Refrigeration System.
CO3	Synthesize the concept of compound refrigeration system.
CO4	Understand the maintenance and analysis of refrigeration system.
CO5	Indentify the concept of Psychometry and comfort air conditioning.

Sr. No.	List of Practical
01	To perform experiments on vapour compression test rig to determine COP of the system.
02	Detailed study of various refrigerants, their classification, properties and characteristic.
03	Demonstration and Study of the classification, characteristic and applications of various types of Compressor.
04	Demonstration and study of various air-conditioning system.

05	Study and demonstration of various psychometric processes.
06	To perform experiments on Air-conditioning test rig to determine its COP.
07	Demonstration of use of various tools and equipment's used for installation, maintenance & repair of refrigeration systems.
08	Testing and charging of vapour compression refrigeration system.
09	To perform experiments on Air Cooler to obtain its performance
10	Design of Ducts for a 100 bedded Hospital/ Hotel.
11	HVAC Design and selection of air conditioning system for commercial building, supermarkets, restaurants, laboratory, etc.
12	Report on visit to refrigeration plant/AC plant/cold storage plant.

RTM Nagpur University-Mechanical Engineering
B.Tech. 8th Semester
Elective – IV: CNC & Robotics (BTME802T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assess	University Exami	Total	
VIII	CNC & Robotics	3			3	30	70	100	3 Hrs

Sr. No.	Course Objective The objective of this course is–
1	To understand details and operations of CNC lathe and milling
2	To understand the fundamentals of robot and its application
	Course Outcomes
After successful completion of this course the student will be able to:	
CO1	Apply basic concepts of NC, CNC and DNC
CO2	Apply programme using manual part programming technique and APT for CNC lathe and machine.
CO3	Identify the basic fundamentals of industrial robots
CO4	Design kinematics of 2 DOF and 3 DOF of 2D manipulators
CO5	Select of appropriate robot for particular application

SYLLABUS	
Contents	No of hours
Unit I Concepts of NC, CNC, DNC, classification of CNC machines, machine configurations, types of control, CNC controllers characteristics, interpolators. cutting tool materials, carbide inserts classification; qualified semi qualified and preset tooling, tooling system for machining centre and turning centre, work holding devices, of CNC Machines. ,	8

Unit II Programming CNC machines, APT part programming using CAD/CAM, parametric programming, NCmanual part programming for CNC turning, milling and machining center.	7
Unit III Fundamentals of Robotics: Introduction Automation & Robotics robot applications robotic systems, robot anatomy and robot configurations, joint types used in robots, robot wrists, joint notation schemes, work value for various robot anatomies, robot specifications, introduction to robot arm dynamics ,	7
Unit IV Robot kinematics – forward & reverse kinematics, forward and reverse transformations of two DOF & three Dof 2-D manipulator , homogeneous transformations. Robot drives and control pneumatic power drives, hydraulic systems, electric drives, teaching of robots, robot programming methods.	7
Unit V Quantitative Techniques for economic performance of robots: Robot investment costs, robot operating expenses. General considerations in robot material handling, material transfer applications, pick and place operations, palletizing and related operations, machine loading and unloading, die casting, plastic moulding, forging, machining operations, stamping press operations using robots	8

References:

Text Books Recommended:

1.CNC Technology and Programming Krar, S., and Gill McGraw Hill publ Co, 1990

2 Industrial Robotics -Technology , Programming and Applications Nicholas Odrey, Mikell Groover McGraw Hill publ Co, July 2017

3 An Introduction to CNC Machining Gibbs, DCasell, 1987

.

Reference Books Recommended:

1.Computer Numerical Control for Machining Lynch, M McGraw Hill, 1992

2 Industrial Automation & Robotics K Goyal, D Bhandari S.k. Kataria & Sons

RTM Nagpur University-Mechanical Engineering
B.Tech. 8th Semester
Elective – IV: CNC & Robotics (BTME802P)
Syllabus (Practical)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
VIII	CNC & Robotics			02	01	25	25	50

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	• Understand the programming of CNC and Robotic system.
CO2	• understand advanced material handling system
CO3	• Recognize automation, sensors and controller technology

List of Practical's

Sr. No.	List of Practical
01	Performance based on Simulation for lathe
02	Performance based on Simulation for CNC milling
03	Performance based on turning operation on CNC lathe machine
04	Performance based on milling operation on CNC milling machine
05	Performance based on pick and place using robot.
06	Performance based on mini conveyor belt for material handling using robot.
07	Performance based categorizing color objects using color sensor and robot.

08	Performance based on detection of objects in front of the photoelectric switch (Proximity Sensor) by using robot.

Suggested References:

1. Automation, Production Systems and Computer Integrated Manufacturing, Mikell P. Groover, Prentice Hall
publication
2. Fundamental of Automation Technology, - F. Ebel, S. Idler, G.Prede, D. Scholz ,Festo Diadick , 2008 Technical Book.

RTM Nagpur University-Mechanical Engineering
B.Tech. 8th Semester
Elective – V: Heating Ventilation and Air-conditioning (BTME803T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assess	University Exami	Total	
VIII	Heating Ventilation and Air-conditioning	3	0	0	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	To provide overview of the HVAC sector and related codes & standards.
2	To enhances the analytical and design skills of the students on heating, refrigeration, ventilation and air distribution system design, chilled water system design and cooling & heating load estimation.
3	To introduce the concept of "Integrated Building Design", related equipment selection & sizing of different HVAC components and project cost estimation and procurement.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Explain the most important concepts about HVACR and operation of HVAC systems.
CO2	Estimate the heating and cooling load of a building.
CO3	Analyse and design different air and water distribution systems related to HVAC systems
CO4	Evaluate the performance of an HVAC system and the energy use of a building.
CO5	Estimate Building Energy and Modeling Methods

SYLLABUS - Elective – V: Heating Ventilation and Air-conditioning	
Contents	No of hours
Unit I **Fundamentals of HVAC :** Introduction to Heating, Ventilation and Air Conditioning, Systems and components, Overview of HVAC Design Procedure, Components of AHU & its function, Sound and Vibration Control, Scope of HVAC industry with overview of the sector, Codes & standards for HVAC systems.	08
Unit II **Cooling and Heating Load Calculations:** Outdoor Design Conditions, Thermal Comfort and Indoor Design Conditions, Internal Heat Sources in Buildings, Transient Effects in Building Energy Transfer, Cooling Load Calculation Methods, Heating Load Calculation Methods, (Numerical treatment is expected).	08
Unit III **Air Distribution Systems:** Total Pressure Distribution, Air Distribution Fans, Fan–Duct Network Interaction, Design Methods for Duct Systems, Optimization of Duct Systems, Air Distribution in Zones (Numerical treatment is expected).	08
Unit IV **Water Distribution Systems:** Energy Equation for Hydronic Systems, Head Losses in Hydronic Systems, Pump Characteristics, System–Pump Interaction and Flow Control, Design of Water Distribution Systems. (Numerical treatment is expected)	08
Unit V **Building Energy Estimating and Modeling Methods:** Degree–Day Method for Estimating Energy Use, Bin Method for Estimating Energy Use, Simulation Methods for Estimating Energy Use (Numerical treatment is expected).	08

References:

Text Books Recommended:

1. Principles of Heating, Ventilation And Air Conditioning With Worked Examples. Nihal E Wijeysundera, World Scientific, 2016.

Reference Books Recommended:

1. Hand Book of Air Conditioning, Shan K. Wang, Macgraw Hill, 2001

2. ASHRAE Handbook Heating, Ventilating, And Air-Conditioning Applications, ASHRAE, Atlanta, GA, 2020.

RTM Nagpur University-Mechanical Engineering
B.Tech. 8th Semester
Elective – V: Electric & Hybrid Vehicles (BTME803T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assess	University Exami	Total	
VIII	Electric& Hybrid Vehicles	3	0	0	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	Explain electric, hybrid electric and plug-in hybrid electric vehicle (PHEV), their architecture, technologies and fundamentals
2	Explain the design, component sizing of the power electronics converters and various electric drives suitable for hybrid electric vehicles
3	Discuss different energy storage technologies used for hybrid electric vehicles and their control and energy balancing techniques
4	Demonstrate different configurations of electric vehicles and charging techniques

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Explain the basics of electric and hybrid electric vehicles, their architecture, technologies and vehicle dynamics fundamentals.
CO2	Analyze the use of different power electronics converters in hybrid electric vehicles.
CO3	Interpret the working of different electrical equipment in electric vehicles and hybrid vehicle configurations
CO4	Explain the use of different energy storage systems used for hybrid electric vehicles, their control techniques, and select appropriate energy balancing technology
CO5	Understand the control and configurations of HEV charging stations

SYLLABUS - Elective – V: Electric & Hybrid Vehicles	
Contents	No of hours
Unit I HEV Fundamentals: Vehicle Basics, Vehicle Resistance: Rolling Resistance, Aerodynamic Drag, Grading Resistance, Dynamic Equation Tire–Ground Adhesion and Maximum Tractive Effort, Power Train Tractive Effort and Vehicle Speed, EV Powertrain Component Sizing. Hybridization of the Automobile: Basics of the EV, Basics of the HEV, Basics of Plug-In Hybrid Electric Vehicle (PHEV) and vehicle architectures: Series Hybrid Vehicle, Parallel Hybrid Vehicle, Basics of Fuel Cell Vehicles (FCVs).	08
Unit II Fundamental of Drives and Control of EV Using DC motor, Induction Motor, Permanent Magnet Motor, Switched Reluctance Motor, BLDC motor, Design and Sizing of Traction Motors Power electronics including switching, AC-DC, DC-AC conversion, electronic devices and circuits used for control and distribution of electric power, Thermal Management of HEV Power Electronics.	08
Unit III Introduction, Different batteries for EV, Battery Characterization, Comparison of Different Energy Storage Technologies for HEVs, Battery Charging Control, Charge Management of Storage Devices, Flywheel Energy Storage System, Hydraulic Energy Storage System, Fuel Cells and Hybrid Fuel Cell Energy Storage System and Battery Management System	08

Unit IV Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems. Matching the electric machine and the internal combustion engine (ICE), Introduction to energy management strategies used in hybrid and electric vehicle, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy strategies	07
Unit V EV Charging Technologies: Classification of different charging technology for EV charging station, introduction to Grid-to-Vehicle, Vehicle to Grid (V2G) or Vehicle to Buildings (V2B) or Vehicle to Home (V2H) operations, bi-directional EV charging systems, energy management strategies used in hybrid and electric vehicle, Wireless power transfer (WPT) technique for EV charging**.**	05

References:

Text Books Recommended:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003

Reference Books Recommended:

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, 2004.
2. Chris Mi, M. Abul Masrur, David Wenzhong Gao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, John Wiley & Sons Ltd. , 2011

RTM Nagpur University-Mechanical Engineering
B.Tech. 8th Semester
Elective – V: Design of Material Handling System (BTME803T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assess	University Exami	Total	
VIII	Design of material Handling System	3			3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	The study of Design of various Mechanical handling system is concerned with understanding of various industrial system and devices with its basic design.
2	The overall objectives of this course is to understand and learn about various industrial mechanical handling devices starting from their basic design for any desired condition and its safety analysis with its theoretical knowledge.
3	This curse includes designed considerations of conveying mechanics like trucks, trolleys, Rope ways, Cranes, Elevators, Draglines, Robotics handling, Belt conveyers, Chain conveyers, screw conveyers, pneumatic conveying system.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Constructional and operational characteristics and design of trolley.
CO2	Constructional and operational characteristics and design of ropeway.
CO3	Constructional and operational characteristics and design of cranes.
CO4	Concept of AGV bulk solid conveying system.
CO5	Concept of Gravity ,powered and vibrating conveying system.

SYLLABUS	
Contents	No of hours
Unit I Constructional features, operation, operational characteristics, advantages, disadvantages, limitations, design considerations of trolley.	8
Unit II Constructional features, operation, operational characteristics, advantages, disadvantages, limitations, design considerations of ropeway.	7
Unit III Constructional features, operation, operational characteristics, advantages, disadvantages, limitations, design considerations of cranes.	7
Unit IV AGV bulk solid conveying: belt conveyors, chain conveyors, roller conveyor, and pneumatic conveying system.	7
Unit V Gravity and powered , screw conveyors , tubular screw conveyors , escalators vibrating conveyors (crank type and spring types).	7

References:

Text Books Recommended:

1. M.P Alexandrov, "Material Handling Equipments" MIR publications.
2. Acma , Reference Book For Belt Conveyor.
3. Citadinov, "Conveying Machines" by MIR publications.
4. Siddhartha Ray, "Introduction to Material Handling ", New Age International Publication
5. ASME, "Materials Handling Handbook", Wiley -Interscience, 1985
6. Spivakovsy A.O. and Dyachkov V K, "Conveying Machines", Volume I and II, MIR Publishers,1985
7. Spivakovskii, "Conveyors and related equipments". MIR publishers
8. Rudenko , "Material Handling Equipments", MIR Publishers

RTM Nagpur University-Mechanical Engineering
B.Tech. 8th Semester
Elective – V: Total Quality Management (BTME803T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assess	University Exam	Total	
VIII	Total Quality Management	3	--	--	3	30	70	100	03

Sr. No.	Course Objective The objective of this course is–
1	To give the students an overview of quality and TQM and explaining the salient contributions of Quality Gurus like Deming, Juran and Crosby. General barriers in implementing TQM.
2	The student would be able to apply the tools and techniques of quality management to manufacturing and services processes.
3	To facilitate the understanding of Quality Management principles and process.
Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	To develop understanding of Quality concepts.
CO2	practically implement the Total Quality Principles to employees and supplier partnership.
CO3	Understanding of Statistical Process Control and Process Capability for enhancement of quality.
CO4	practically implement the tools for Total Quality Principles .
CO5	Develop Understanding of Quality System , Quality Audits, Leadership & quality council & overview of software used for TQM.

SYLLABUS	
Contents	No of hours
Unit I – Introduction to Total Quality Management Concept of Quality, Need for Quality, Definition of Quality, Dimensions of a Product and Quality of Service, Concept of TQM, Framework of TQM, Contributions of Deming, Juran, and Crosby, Obstacles in TQM, Customer and his perception of Quality, Customer retention ,	**(8 hours)**
Unit II– Principles of Total Quality Management Continuous process improvement - PDCA cycle, 5S, Kaizen, 8D Methodology, Supplier partnership, Partnering, Supplier selection, Supplier Rating, Taguchi technique – Introduction, Loss Function, Parameter, and Tolerance Design, Signal to Noise ratio ,	**(8 hours)**
Unit III – Statistical Process Control and Process Capability Statistical Process Control- Central Tendency, Normal curve**,** Control Charts, Process Capability, Quality Function Development (QFD), TPM - Concepts, improvement needs - Performance measures	**(7 hours)**
Unit IV - Tools and Techniques in Total Quality Management The seven traditional tools of quality, New management tools, Six-sigma: Concepts, Methodology, Applications to Manufacturing, and Service Sector including IT, Benchmarking - Reason to benchmark, Benchmarking process, FMEA Stages and Types.	**(7 hours)**
Unit V – Quality Systems in Total Quality Management Introduction to IS/ISO 9004:2000, Quality Management Systems, Guidelines for performance improvements, Quality Audits, TQM culture, Leadership and Quality Council, Employee Involvement in TQM, Motivation, Empowerment, Recognition and reward, Overview of software used for TQM.	**(8 hours)**

Note –*Students are expected to complete one case-study based on or using the concepts of TQM in an industry individually. Faculty shall ask the students to submit the report based on this case study as a part of the curriculum term work.*

References:

Text Books Recommended:

1.Total Quality Management: Dale H. Besterfield, Carol Besterfield - Michnaetal, Pearson.
2.ShridharaBhat K, Total Quality Management – Text and Cases, Himalaya Publishing House

Reference Books Recommended:

1.L Suganthi, Anand A Samuel, Total Quality Management, PHI
2. Lt.Gen. Lal H, Total Quality Management, Wiley Eastern Limited
3.Greg Bounds, Beyond Total Quality Management, McGraw Hill Publishers
4.Menon H G, TQM in New Product Manufacturing, McGraw Hill Publishers

RTM Nagpur University-Mechanical Engineering
B.Tech. 8th Semester
Elective – VI: Industrial Internet of Things (IOT)
(BTME804T)Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assess	University Exami	Total	
VIII	Industrial IOT	3	-	-	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	To provide knowledge of key enablers of Industrial IOT Systems.
2	To understand the importance of industrial automation and industrial maintenance for reducing the production loss.
3	To acquainted with the challenges of IoT implementation in industry.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	To select sensors as per the industry based IoT applications including in-sensor processing, data conditioning, mounting methods etc.
CO2	To design communication technologies on the basis of data transfer rate, power/energy requirements and throughput requirements.
CO3	To implement the key enablers of industrial IoT systems such as AR, VR, cloud computing, application softwares in the field of industrial IoT.
CO4	To design predictive maintenance strategy for the critical processes of the industry by using IoT concept to reduce the production loss of the industry.
CO5	To apply the IoT concepts in building solutions to industrial problems.

SYLLABUS	
Contents	No of hours
Unit I **Introduction to Industrial IoT:** Industrial revolution, role of Internet of Things (IoT) & Industrial Internet of Things (IIoT) in Industry 4.0, key technologies in Industry 4.0, concept of Smart Factories, elements of smart factories.	**07**
Unit II **Implementation systems for IIoT:** Sensors and Actuators for Industrial Processes, Sensor networks, Data Acquisitions on IoT Platform, Wireless Sensor nodes with Bluetooth, WiFi, and LoRa Protocols, IoT Gate way, IoT Edge Systems and It's Programming	**07**

Unit III **Cyber Physical Systems (CPS):** Architecture of CPS, features of CPS, Role of key technologies of industry 4.0 in industrial operations such as Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis	**07**
Unit IV **Predictive Maintenance with IIoT technology:** Industrial maintenance strategies, need of effective maintenance strategies, predictive maintenance with IIoT technologies and its architecture, design of IIoT system for condition monitoring.	**08**
Unit V **Industrial IoT- Applications:** Challenges of IoT implementation. Application of IoT in Power Plants, marine, aviation, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications).	**07**

References:

Text Books Recommended:

1. Industry 4.0: The Industrial Internet of Things Alasdair GilchristPublications: Apress
2. The Concept Industry 4.0 An Empirical Analysis of Technologies and Applications in Production Logistics Authors: Bartodziej, Christoph Jan Springer: Publication in the field of economic science.
3. Embedded System: Architecture, Programming and Design by Rajkamal, TMH3.

Reference Books Recommended:

1. Dr. OvidiuVermesan, Dr. Peter Friess, "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers

RTM Nagpur University-Mechanical Engineering
B.Tech. 8th Semester
Elective – VI: Additive Manufacturing (BTME804T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assess	University Exami	Total	
VIII	**Additive Manufacturing**	3	-	-	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	Use commercial software for digitizing free-form geometry.
2	Create the design of an object suitable for additive manufacturing processes.
3	.Compare traditional versus next generation manufacturing
4	Define and apply criterion for selecting appropriate additive manufacturing process for any given application.
Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Explain the evolution of additive manufacturing (AM) and its importance in digital manufacturing. Also, create AM process chain for product.
CO2	Create and pre-process a model for additive manufacturing.
CO3	Explain liquid based and solid based additive manufacturing processes
CO4	Explain powder based additive manufacturing process
CO5	Post process the additive manufactured parts.

SYLLABUS	
Contents	No of hours
Unit I Need - Development of Additive Manufacturing (AM) systems, Distinction between AM & CNC machining, AM process chain: Conceptualization, 3D Scanning & the Scanning Process ,CAD, conversion to STL, Transfer to AM, STL file manipulation, Machine setup, build , removal and clean up, post processing. Impact of AM on Product Development - Virtual Prototyping - Rapid Tooling – Rapid Prototyping (RP) to AM - Classification of AM processes, Benefits and Applications. ,	8
Unit II **Reverse engineering and CAD modeling:** Basic concepts - Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements. Introduction to Geometric modeling techniques: Wire frame, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation - Software for AM - Case studies. ,	8
Unit III **Liquid based and Solid based additive manufacturing systems:** Stereo lithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, Recoating issues, materials, advantages, limitations and applications. Fused Deposition Modelling (FDM): Principle, details of processes, process variables, types, products, materials and applications.	7
Unit IV **Powder based additive manufacturing systems:** Selective Laser Sintering (SLS): Principle, process, Indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications– Case Studies.	7
Unit V **Post processing of AM parts:** Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques.	6

References:

Text Books Recommended:

1. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.

2. Chua Chee Kai, Leong Kah Fai, "Rapid Prototyping: Principles & Applications", World Scientific, 2003.

3. Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010

4. Ali K. Kamrani, Emand Abouel Nasr, "Rapid Prototyping: Theory & Practice", Springer, 2006.

5. D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer 2001

Reference Books Recommended:

1. Gebhardt, A., "Rapid prototyping", Hanser Gardener Publications, 2003.

2. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications : A tool box for prototype development", CRC Press, 2011.

3. Kamrani, A.K. and Nasr, E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.

4. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.

RTM Nagpur University-Mechanical Engineering
B.Tech. 8th Semester
Elective – VI: Energy Conservation & Management (BTME804T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assess	University Exami	Total	
VIII	Energy Conservation & Management	3	-	-	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	This Course is designed to help students understand the importance of energy systems in working and the need to conserve energy.
2	This course aims to familiarize Energy Auditing in Industries and its Methodology with all the parameters and Instruments involved.
3	The students will be able to apply the core-requisite knowledge of Engineering Thermodynamics and Energy Conversions to come up with Energy Saving techniques in Industries.
4	This course also aims to gain knowledge of applying financial appraisal techniques to energy saving projects.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Identify and classify areas of energy conservation in industries.
CO2	Know the duties and responsibilities of an energy manager and energy auditor.
CO3	Analyze and modify existing working of the energy utilizing and generating machines.
CO4	Know how to use instruments in energy audit process.
CO5	Implement proper energy saving techniques in boiler, furnaces etc.

SYLLABUS - Elective – VI: Energy Conservation & Management	
Contents	No of hours
Unit I Energy scenario, Classification of Energy, Primary and Secondary Energy, Commercial Energy and Non-commercial Energy, Renewable and Non-Renewable Energy, Indian Energy Scenario. Long Term Energy Scenario for India, Energy Pricing in India, Energy Security, Energy Conservation and its Importance, Energy Strategy for the Future, The Energy Conservation Act, 2001 and its Features. Various Forms of Energy, Electrical Energy Basics, Thermal Energy Basics, Units and Conversions.	08
Unit II Energy management and audit, Definition & Objectives of Energy Management, Energy Audit: Types and Methodology, Understanding Energy Costs, Energy Audit Instruments. Financial management, Introduction, Investment Need, Appraisal and Criteria, Financial Analysis, Financial Analysis Techniques - simple payback period, return on investment, net present value, internal rate of return, cash flows, Sensitivity and Risk Analysis, Financing Options, energy performance contracts and role of Energy Service Companies (ESCOs).	08
Unit III Energy Efficiency in Boilers and allied system: Introduction, Boiler Systems, Boiler Types and Classifications, Performance Evaluation of Boilers, Energy Conservation Opportunities, Case Study. Cooling Tower: Performance evaluation, efficient system operation, and energy saving opportunities, assessment of cooling towers. Energy efficiency in furnaces, Performance Evaluation of a Typical Furnace, General Fuel Economy Measures in Furnaces.	08

Unit IV Energy efficiency in compressed air system and HVAC system: Introduction: Compressor Performance, Compressed Air System Components, Efficient Operation of Compressed Air Systems, Compressor Capacity Assessment, Energy Efficiency in Compressed Air System. Heating, ventilation, air conditioning and Refrigeration System. Energy efficiency in pumps and pumping system, Factors Affecting Pump Performance, Efficient Pumping System Operation, Flow Control Strategies, Energy Conservation Opportunities in Pumping Systems.	07
Unit V Global environmental concerns, Global Environmental Issues, Ozone Layer Depletion, Global Warming, Loss of Bio-Diversity, Climate Change Problem and Response, Kyoto Protocol, The Conference of the Parties (COP), Prototype Carbon Fund (PCF), Clean Development Mechanism (CDM), Sustainable Development.	05

References:

Text Books Recommended:

1. Energy Engineering and Management Amlan Chakrabarti Prentice hall India 2011.
2. Energy Management Principles, CB Smith, Pergamon Press, New York.
3. Book 1,2,3,4, Energy Manager and Energy Auditor Examination, Bureau of energy efficiency, New Delhi.

Reference Books Recommended:

1. Energy Management Hand Book. W. C. Turner.John Wiley and sons.
2. Handbook on Energy Efficiency, TERI, New Delhi, 2009.
3. Energy Auditing and Conservation; Methods, Measurements, Management & Case Study, Hamies, Hemisphere Publishing, Washington, 1980

RTM Nagpur University-Mechanical Engineering
B.Tech. 8th Semester
Elective – VI: Green & Sustainable Manufacturing (BTME804T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assess	University Exami	Total	
VIII	Green & Sustainable Manufacturing	3	-	-	3	30	70	100	3Hrs

Sr. No.	Course Objective The objective of this course is–
1	To Study Importance of Environment conscious manufacturing (Green Manufacturing).
2	To achieve sustainability through manufacturing
3	To conserve natural resources for future generation through green manufacturing practices
	Course Outcomes
After successful completion of this course the student will be able to:	
CO1	Get acquainted with the current global and Indian manufacturing scenario and challenges with respect to environment
CO2	Get acquainted with the green manufacturing concept and its need in global and Indian context
CO3	Get conversant with the various Key GM Operational Technologies, approaches, strategies, and Elements
CO4	Get acquainted with International and National Green regulations,. International Treaties supporting GM
CO5	Get conversant with the Conceptual GM model. Performance measurement tools & Green economics for GM, Analytical Tools for Sustainability Assessment, Life Cycle Assessment

SYLLABUS	
Contents	No of hours
Unit I Manufacturing in industries, Definition, Importance of Green Manufacturing(GM) & Sustainable manufacturing (SM),, Need for public awareness for GM, Major Environmental Issues , Ozone depleting gases – Green House Effect – Green House Gases and Global Warming ,Air Pollution, Impact of Large industries, Small & medium enterprises (SMEs) on environment, ,Industrial Pollution Indian Scenario,	7Hrs
Unit II Introduction of Green and sustainable Manufacturing - Understand global business conditions and the need for integrating sustainability into existing continuous improvement initiatives, Need for GM and SM in Production ; Origin and Overview of GM:- Evolution & overview of Green manufacturing practices. Sustainability and global conditions, The Clean production concept, GM for Sustainable Development Green Manufacturing Practices (Country Specific and Industry Specific),Various green practices pursued by major companies ,	7Hrs
Unit III The Three Rs (Reduce, Recycle and Reuse) in Manufacturing Industries:& 6R'sin Sustainable manufacturing i.e. reduce, reuse, recycle, recover, redesign and re manufacturing, GM Operational Technologies, GM Approaches/strategies, Elements of GM ,Green Design (Design for the Environment) (DfE) ,Life Cycle Analysis or Assessment (LCA),Green Process Planning, Green Supply Chain (GSC),Reverse Logistics (RL),Green purchasing and Marketing, Green productivity, Green Disposal) ,GM in Industry 4.0 scenario. ,	8Hrs
Unit IV International and National Green regulations,. International Treaties. international and National Regulation on Environmental Sustainability and its Sectoral Impact; GM legislation / directives, Kyoto Protocol ,International Green Regulations, Waste Electrical and Electronic Equipment (WEEE) Directive, Restrictions of Hazardous Substances (RoHs) Directive, End of Life Vehicle (ELV) Directive, The Take-back law, ISO 14000 series of standards for GM	7Hrs
Unit V Case Study for establishing GM model for manufacturing industry. Case study for identifying the critical success factors(drivers) and performance measure of GM in manufacturing industry ,Establishing the relationship and framing the GM model based on identifying drivers and measures using suitable statistical tool or software.{students are expected to perform case study and establish model for GM through case study} ,	8Hrs

References:

Text Books Recommended:

•"21st century management : a reference handbook" Edited by: Charles WankelSAGE Publications, Inc., 2008.

•"Handbook of environmentally conscious manufacturing" Edited by: Christian N. Madu London : Kluwer Academic Publishers, 2001.

•"Industrial Ecology" T.E. Graedel & B.R. Allenby Pearson Education, Inc. 2003.

Reference Books Recommended:

•. "Greener manufacturing and operations: from design to delivery and back'Edited by: Joseph Sarkis Greenleaf Pub., 2001.

• An Introduction to Alternative Energy Sources: Ranky, P.G. An interactive multimedia 3D eBook publication by CIMware USA, Inc. and CIMware Ltd., UK, ISBN 1-872631- 97-5, 2008

RTM Nagpur University-Mechanical Engineering
B.Tech. 8th Semester
Project Phase II (BTME805P)

Sr. No.	Course Outcomes
After successful completion of this course the student will be able to:	
CO1	Convert their conceptual ideas into working projects .
CO2	Explore the possibility of publishing papers in journal.
CO3	Enhance their knowledge through an on-line collection of evidence, work and other information.
CO4	Ultimately promotes for inter-personal communication, punctuality, demonstration of appropriate written and oral communication skills with overall Work-Integrated-Learning.
CO5	Develop an understanding of social, cultural, professional, ethical, global and environmental responsibilities of the professional Engineer.

Note: A load of 4 hours/week per project guide for the course "Project Phase II"