RTM Nagpur University- Mechanical Engineering
B.Tech 5th Semester
Heat Transfer (BTME501T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
V	Heat Transfer	3	-	-	3	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 analyze radiation with and without radiation shield. In addition, it also discusses methods to analyze & 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.
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 to deliver a desired heat transfer rate.

SYLLABUS	
Contents	No of hours
Unit I **Introduction to heat transfer**, Basic modes of Heat Transfer, Conduction, Convection & Radiation. Laws of Heat transfer, General heat conduction equation in Cartesian coordinate system (Derivation), General heat conduction equation in Cylindrical and Spherical coordinates (Only expression). One dimensional steady state heat conduction equation for plane wall, cylinder and sphere, Overall heat transfer coefficient. Thermal resistance of composite structure, contact resistance, critical thickness of insulation. (Numerical treatment expected)	07
Unit II **Conduction with internal heat generation** for plane wall, Cylinder and Sphere Numericals on plane wall only. **Unsteady state heat transfer**, lumped heat capacity analysis, Heisler's charts. Biot's Number, Fourier's Number & its significance. **Extended surface**, Types of Fins, temperature distribution and their heat transfer rate, Fin efficiency & Effectiveness. (Numerical treatment expected).	07
Unit III **Forced convection** :Concept of hydrodynamics & thermal boundary layer thickness, local and average heat transfer coefficient. Flow over flat plate, cylinder. Laminar & turbulent flow through pipe.(Numerical treatment expected). **Free or Natural Convection** :Flow over horizontal and vertical plates, cylinders (Numerical treatment expected) **Boiling and Condensation heat transfer**: Pool boiling curve and regimes of pool boiling, Film and Drop wise condensation (Only theoretical concept).	07
Unit IV **Radiation:** Radiation from all bodies, Laws of radiation, Emissivity, Absorptivity, Transmissivity, Reflectivity, Radiosity, Emissive power, Irradiation, Shape Factor. Laws of Shape Factor,Radiation exchange between parallel plates, cylinder & spheres. (Numerical treatment expected). Radiation shields (Only Concept).	07
Unit V **Heat exchanger**: Detail Classification, Overall Heat Transfer Coefficient, Fouling Factor, LMTD & Effectiveness -NTU method of heat exchanger analysis for parallel, counter flow arrangement. (Numerical treatment expected).	07

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 Publications Pvt. 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.

RTM Nagpur University- Mechanical Engineering
B.Tech 5th Semester
Heat Transfer Lab (BTME501P)
Syllabus (Practical)

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

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.
CO5	Student will able to select the proper heat exchangers per system requirements.

List of Practical's

Sr. No.	List of Practical's
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.
06	To determine heat transfer coefficient in forced convection for fluid flowing through a duct.
07	Determination of temperature distribution & heat transfer rate from fin under free and forced convection.
08	Determination of emissivity of non-black body.
09	To determine the effectiveness of a concentric tube heat exchanger.
10	To determine the critical heat flux.
11	Determination of heat transfer rate in unsteady state heat transfer.
12	To determine the heat transfer coefficient in film wise and drop wise condensation.

13	Determination of performance of shell and tube heat exchanger using computer-based setup.
14	Minimum 2-3 virtual experiment to be conducted.
15	Study of various types of Heat Exchangers.

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

RTM Nagpur University- Mechanical Engineering
B.Tech 5th Semester
Energy Conversion - I (BTME502T)
Syllabus (Theory)

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

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 the steam generators (i.e. Boilers), boiler mountings & accessories. Also evaluate the 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 the steam condensers, cooling towers and evaluate performance parameters of surface condenser.

SYLLABUS	
Contents	No. of hours
Unit I Introduction to layout of thermal power plant, Principle of steam generation, necessity of water treatment, Classification of steam generators (i.e. Boilers), comparison of fire tube & water tube boilers, high pressure boilers, boiler mountings and accessories. Performance of steam generators: Evaporation capacity, equivalent evaporation, boiler efficiency and preparation of Heat balance sheet of boiler.	08
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) Coal handling systems and ash handling systems.	07
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.	07
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 simple Impulse turbine, Reaction turbine and two stage impulse turbine is expected)	08
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	07

References:

Text Books Recommended:

1. A Course in Power Plant Engineering, S.C. Arora S.Domkundwar & V.M. Domkundwar, Dhanpat Rai & Co Publications.
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 & Co Publications.

.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.

RTM Nagpur University- Mechanical Engineering
B. Tech 5th Semester
Design of Machine Elements (BTME503T)
Syllabus (Theory)

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

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

Successful completion of this course the student will be able to:

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

SYLLABUS	
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
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
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.	10
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.	08
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.	10

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.

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.

RTM Nagpur University- Mechanical Engineering
B.Tech 5th Semester
Industrial Economics & Management (BTME504T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
V	Industrial Economics & Management	3	-	-	3	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	
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
B.Tech 5th Semester
Mechanical Measurement and Metrology (BTME505T)
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
V	Mechanical Measurement and Metrology	3	-	-	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	This course is designed to learn and understand need of measurements and static characteristics of instruments
2	It will help the students to system with time domain to identify the response time.
3	To impart the knowledge about the functioning of instrumentation and measurement process.
4	It aims to perform the assessment of production design and calculation.
5	It provides a basic knowledge metrological measurement.

Course Outcomes

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

CO1	Students will be able to analyze statistical characteristic of systems.
CO2	Students will be able asses the system response.
CO3	Students will be able to understand the instrumentation process.
CO4	Students will be able to understand limits fits and tolerance.
CO5	Students will learn the basics of various metrology measurement terms and techniques.

SYLLABUS	
Contents	No of hours
Unit I **Static Characteristics** Purpose, structure and elements of measuring system. Static characteristics of measurement system, elements including systematic, statistical characteristics, generalized model of system elements and calibration. Error measurement (Analytical Treatments is expected)	07
Unit II **Dynamic characteristics** of measurement system. Dynamic Characteristics, standard test inputs, order of system, dynamic analysis, system response to first and second order system using step and ramp input, time domain response. Introduction to noise in measurement system ([illegible]).	07
Unit III Construction, Range and working of instruments for measurement of Linear and Angular Displacement, Speed, Load, Strain, Force, Torque and Power. (Analytical treatment not included) Construction, Range and working of instruments for measurement of Pressure, Vacuum, Sound, Light and Temperature.(Analytical treatment not included)	07
Unit IV **Standards of Measurement**, Line, End and Wavelength standard. Working standards, Requirement interchangeability, Allowance and Tolerance, Selective assembly. **Limits and Fits**, Tolerance analysis of Limits and Fits, Types of limit gauges, Types of fit, Shaft and Hole basis system, Design of Limit gauge (Analytical treatment is expected) and Introduction to Process planning sheet	07
Unit V **Measurement of Straightness and of Flatness**. Instruments for Linear and Angular Measurement. (Vernier, Angle gauge, Sine bar, Level indicator, Clinometers and Taper gauge) **Comparators:** Mechanical, Optical, Electrical, Electronic, Pneumatic. Study and use of Optical profile projectors, Tool maker's microscope and Autocollimator.	07

Books Recommended

TEXT BOOKS:

1. Mechanical Measurement and Control, D.S. Kumar, Metropolitan Book Co.
2. Instrumentation Measurement and Analysis, B.C. Nakra, K.K. Choudhary, TMH
3. Measurement Systems, Ernest O. Doebelin, Dhanesh N. Manik, TMH
4. Mechanical Measurement, Thomas G. Beckwith, Pearson.
5. Metrology and Measurement, Anand K. Bewoor, Vinay A. Kulkarni, TMH
6. Metrology, R. K. Jain, Khanna Publishers.
7. A Textbook of Engineering Metrology, I. C. Gupta, Dhanpat Rai & Sons Publication.

REFERENCE BOOKS:

Principles of Measurement Systems, John P. Bentley, Pearson

RTM Nagpur University- Mechanical Engineering
B.Tech 5th Semester
Mechanical Measurement and Metrology Lab (BTME505P)
Syllabus (Practical)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
V	Mechanical Measurement and Metrology Lab	-	-	2	1	25	25	50

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Students will be able to perform the instrumentation.
CO2	Students will be able to use the instrumentation for measurement of thermal properties.
CO3	Students will be able obtain the response from the instruments also can be able to calibrate the instruments.
CO4	Students will be able to calculate the limits and allowances to obtain the proper fit.
CO5	Students will able to identify the surface roughness using optical flat.

List of Practical's

Sr. No.	List of Practical's - Mechanical Measurement and Metrology
01	Static characteristic of at least one Instrument.
02	Static calibration of at least one Instrument.
03	3, 4 & 5. – Measurement of parameters by minimum three different types of Instruments
04	Measurement of Linear, Angular dimensions (Using Vernier, Sine bar, Clinometers)
05	Measurement of Flatness & Straightness.
06	Study and Measurement of Parameters using Toolmaker's microscope
07	Study and Measurement of Parameters using Optical profile projector
08	Use of Optical flat
09	Design of Limit gauge

Minimum Eight out of the following shall be performed.

RTM Nagpur University- Mechanical Engineering
B.Tech 5th Semester
Industrial Visit (BTME506P)
Syllabus (Practical)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
V	Industrial Visit	-	-	2	1	50	-	50	-

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	Acquire in depth knowledge about industries & innovative technologies employed.

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, policy makers, 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 andexperienced 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 theyare 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 teamworkabilities. 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 includingthe timings?
4. Have you elaborated the risk assessments to the students and the safety procedure along withthe 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 theschool 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 willmeet 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 committeevisits.

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

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

RTM Nagpur University- Mechanical Engineering
B.Tech 5th Semester
Performing Art (BTME507P)
Mandatory Course
Syllabus (Practical)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
V	**Performing Art**	-	-	2	Audit (0)	-	-	-	-

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

- Empower the students in 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.
- It helps in selecting future options.

Performing Art –Suggested Activities. However Institutes are free to design their owncourse 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
6th Semester
Automation In Production (BEME601T)
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	1	0	4	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 (BEME601T)**	
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
6th Semester
Automation In Production (BEME601P)
Syllabus (Practical)

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**	-	-	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
6th Semester
Energy Conversion-II (BEME602T)
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	1	-	4	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
6th Semester
Energy Conversion-II (BEME602P)
Syllabus (Practical)

Semester	Course Title	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Evaluation	University Examination	Total
B.Tech 6th Sem Mechanical	**Energy Conversion-II Lab**	0	0	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
6th Semester
Dynamics of Machines –(BEME603T)
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	1	-	04	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
6th Semester
Dynamics of Machines –(BEME603P)
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 Machine	-	-	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
6th Semester (Elective- I)
Mechanical Vibrations-(BEME604T)
Syllabus

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	Elective -I Mechanical Vibrations	3	1	0	4	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	To understand and analyse vibrations in various mechanical systems and using mathematical treatment design vibration isolators and methods of vibration reduction.
Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Establish mathematical model and determine natural frequencies of single and two DOF systems
CO2	Apply different methods to design vibration absorbers.
CO3	Understand vibrations in multi degree of freedom system and able to prepare vibration models
CO4	Analyse vibrations in continuous systems
CO5	Use finite element method in vibration analysis.
CO6	To measure and analyse vibrations using vibration monitoring devices

Syllabus- Mechanical Vibrations, 6th Semester , Mechanical Engineering	
Contents	No of hours
Unit I - Free & forced vibration, undamped and damped single degree of freedom systems subjected to harmonic and other periodic excitations. Convolution integral and response to arbitary excitation. Vibration isolation and transmissibility. Solution using laplace transforms, Runga kutta method, structured damping, estimation of natural frequency for single and two degree of freedom.	8
Unit II- Energy method applied to multi degree freedom system. Lagranges equation. Transient response of one degree-of-freedom systems. Generalized formulation of mass, damping and stiffness matrix and its numerical solutions. Vibration absorber, Influence Coefficients and flexibility matrix of bending vibration of beam and multi-disc rotor. Mode shapes and orthogonality principle, Steady-state response to harmonic excitation.	8
Unit III – Numerical techniques for Multi degree of freedom systems. Matrix iteration method. Holzer's method for torsional vibration. Dunkeleys method for critical speed determination of multi disc rotor. Rayleigh Ritz, Stodola method for determination of all the natural frequencies and mode shapes. Modal matrix and expansion theorem. Free and forced response by modal analysis.	8
Unit IV - Vibration of continuous system, Vibration of elastic bars. Axial vibration of rod, bending vibration of beam and torsional vibration of shaft. Hamiltons principle and derivation of equation of motion, Rayleigh quotient. Modal co-ordinates and modal forces. Free and forced response through modal analysis. Introduction to Finite Element Method in vibration of continuous system.	8
Unit V - Vibration pickup, seismometers, accelerometer, proximity probe spectrum analyzer, FFT & DFT (DiscreteFT), vibration measurement, digital vibration measurement, philosophy of vibration condition monitoring	6

Sr. No.	List of Tutorials
01	Problems on determination of natural frequency of 2 DOF system and transmissibility
02	Problems on design of vibration isolators
03	Problems on determination of critical speeds
04	Problems on response through modal analysis
05	Problems mode shape computation for simple rod and beam problem.

References:

Text Books:

1. Mechanical Vibration, V. P. Singh, Dhanpatrai & Co.
2. Mechanical Vibrations, J. S. Rao, New Age publishers.
3. Mechanical Vibration, Shrikant Bhave, Pearson publications.
4. Theory of Vibration, W.T. Thomson, CBS.
5. Mechanical Vibration, Debabrata Nag, Wiley.

Reference Books Recommended:

1.Mechanical Vibrations, S.S. Rao, Pearson.
2. Advanced Theory of Vibration, J.S. Rao, New Age International.
3. Vibration Condition Monitoring of Machines, J. S. Rao, Narosa publications.
4. Random Vibration in Mechanical Systems, Crandall & Mark, Academic press.
5. Mechanical Vibration, William J.Palm, John Wiley.

RTM Nagpur University- Mechanical Engineering
6th Semester-Elective-I
Synthesis of Mechanisms –(BEME604T)
Syllabus

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	Univ Exam	Total	
B.Tech 6th Sem Mechanical	**Elective -I Synthesis of Mechanisms**	3	1	-	04	30	70	100	3

Sr. No.	Course Objective The objective of this course is
1	To enrich the students with different methods of contriving the mechanisms depending on the needs of input output motion, positions of points and the applications by applying their intuition.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Critically analyze the existing machines and mechanisms
CO2	Synthesize mechanisms quickly using graphical technique
CO3	Synthesize mechanisms using analytical technique and prepare computer algorithms.
CO4	Synthesize mechanisms using coupler curves as per the motion requirement
CO5	Understand spatial mechanisms and apply it for design of robotic manipulators

Syllabus- Synthesis of Mechanisms (Elective I), 6th Semester , Mechanical Engineering	
Contents	No of hours
Unit I – Introduction Types of mechanism, kinematics synthesis, science of relative motion, tasks of kinematic synthesis. Function generation, Path generation & Motion generation problem with practical applications. Concept of Transmission angle, limiting conditions, toggle position, circuit and branches in linkages. Degree of Freedom, Class-I, Class-II Chain. Harding's notations, Grashof criterion, Grubler's criterion, .	9
Unit II – Graphical Synthesis Co-ordination of input-output link motion, relative pole technique, inversion technique, overlay technique, graphical synthesis of Quick-Return Mechanism for optimum transmission angle. Introduction to path generation problem , synthesis for path generation, with & without prescribed timing using graphical method, Kinematic Synthesis of planar mechanisms, accuracy (precision) points, Chebesychev spacing, types of errors,	9
Unit III – Analytical synthesis Synthesis of four-bar mechanisms. Freudenstein's equation, synthesis for three, four and five accuracy points. Introduction to computer aided analysis and design of mechanism using computer programming.	9
Unit IV – Coupler curves Equations of coupler curve, Robert-Chebychev theorem, double points and symmetry.	9
Unit V - Spatial Mechanisms and Robotics Introduction, mobility, describing spatial motions, Kinematic analysis and synthesis of spatial mechanisms, Kinematics of robotic manipulators	9

Tutorials: Based on above syllabus units

References:

Text Books Recommended:

1. Theory of Machines and Mechanisms, J. E. Shigley and J. J. Uicker, McGraw-Hill.
2. Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines, Robert L.Norton, Tata McGraw Hill.

Reference Books Recommended:

1. Advanced Mechanism Design–Analysis and Synthesis - Vol. I and II, A.G.Erdman and G.N. Sandor, Prentice – Hall.
2. Kinematics and Mechanism Design, C.H. Suh and C.W. Radcliffe, John Wiley & Sons.
3. Kinematics and Linkage Design, Hall, A.S., Balt Publishers.
4. Kinematic Synthesis of Linkages, R.S. Hartenberg and J. Denavit, McGraw Hill.
5. Kinematics and Dynamics of Machinery, R L Norton, McGraw Hill.
6. Mechanism synthesis and analysis, A. H. Soni, McGraw Hill

RTM Nagpur University-Mechanical Engineering
6th Sem-(Elective-I)
Operation Research(BEME604T)
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	0	0	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(BEME604T)-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
6th Sem- (Elective-I)
Production Planning and Control-(BEME604T)
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	0	0	3	30	70	100	3 hrs

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
6th Sem (Elective- 1)
Convective Heat Transfer-(BEME604T)
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	**Elective- 1 Convective Heat Transfer**	3	-	-	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	Learn the various aspects of convective heat transfer and laws associated with it
2	Apply their knowledge of basic heat transfer for a detailed analysis of forced and free convection
3	Solve real-life problems related to heat transfer.
4	Design of heat transfer equipment for industrial application
Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Explain the fundamental and advanced principles of forced and natural convection heat transfer processes.
CO2	Apply the principles of natural convective to estimate the heat dissipation from external flow devices.
CO3	Solve the problem of internal flow natural convection.
CO4	Relate to the current challenges and opportunities in the field of turbulent convective heat transfer.
CO5	Formulate and solve problems related to external wall flows and convection heat transfer.

SYLLABUS- Convective Heat Transfer	
Contents	No of hours
Unit I : Fundamental equations, Dimensionless numbers, Flows with variable physical properties: heat transfer in a laminar Couette, Flows with dissipation, cooling of a sphere by a gas flow. Laminar Fully Developed Forced Convection in Ducts: Hydrodynamics, Heat transfer in a parallel-plate channel with uniform wall heat, Flow in a plane channel insulated on one side and heated at the uniform temperature on the opposite side. Protection of a wall by a film of insulating material, cooling of a moving sheet.	10
Unit II : External Natural Convection: Introduction, Boussinesq model, Dimensionless numbers Scale analysis, Natural convection near a vertical wall, Integral method for natural convection, Correlations for external natural convection, Mixed convection.	9
Unit III : Internal Natural Convection: Introduction, Scale analysis, fully developed regime in a vertical duct heated at constant temperature, Enclosure with vertical walls heated at constant temperature.	9
Unit IV : Turbulent Convection: **Internal Wall Flows**: Introduction, Hydrodynamic stability and origin of the turbulence, Reynolds averaged Navier-Stokes equations, Wall turbulence scaling, Eddy viscosity-based one point closures, Empirical correlations, Exact relations for a fully developed turbulent channel flow	9
Unit V Turbulent Convection: External Wall Flows: Introduction, Transition to turbulence in a flat plate boundary layer Equations governing turbulent boundary layers, Scales in a turbulent boundary layer Velocity and temperature distributions, Integral equations, Analogies Integral formulation of boundary layers over an isothermal flat plate.	8

References:

Text Books Recommended:

1. Convective Heat Transfer: Solved problems by Michel Favre-Marinet and Sedat Tardu; John Wiley & Sons, Inc.
2. Convective Heat and Mass Transfer by W. M. Kays and M. E. Crawford; McGraw Hill.
3. Convective Heat Transfer by Adrian Bejan; John Wiley and Sons.

.

Reference Books Recommended:

1. Introduction to Convective Heat Transfer Analysis by Patrick H. Oosthuizen and David Naylor.
2. Yunus A. Cengel, Heat Transfer A Practical Approach – Tata McGraw Hill - Second Edition 2014.
3. Frank P. Incropera and David P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley & Sons, Seventh Edition, 2011.

RTM Nagpur University-Mechanical Engineering
6th Sem (Elective- 1)
Power Plant Engineering-(BEME604T)
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 I)**	3	-	0	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

.

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
6th Semester-Elective-II
Tribology –(BEME605T)
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	Elective-II **Tribology**	3	1	--	4	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	Students should understand the concepts of friction, wear and the methods of avoiding them through proper lubrication and bearing design.

Course Outcomes

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

CO1	Select materials and lubricants to suggest a tribological solution to a particular situation.
CO2	Understand the concept of thermal equilibrium and heat balance
CO3	Apply the basic knowledge to design simple journal bearings
CO4	Design thrust and step bearings
CO5	Design and selection of antifriction bearings
CO6	Understand friction and effects as wear, wear mechanisms, wear resistant materials

Syllabus- **Tribology**, (Elective II) , **6th Semester , Mechanical Engineering**	
Contents	No of hours
Unit I - Lubrication: Introduction, properties and testing of lubricants, viscosity, effect of temperature and pressure on viscosity, basic equations, generalized Reynold's equation, energy equation of state. Wear: wear of metals, classification of wear, mechanisms of wear, quantitative laws of wear, wear resistant materials. . Friction: Friction of metals, friction theories, surface contaminants, frictional heating.	9
Unit II- Idealized hydrodynamic bearings, plane slider bearings, slider bearing with pivoted shoes, step bearings, idealized journal bearings, finite bearings, electrical analogy method, analytical solution, numerical solutions, oil flow and thermal equilibrium, circumferential and axial flow, heat balance.	9
Unit III – Bearing design, practical considerations, design of journal bearings, squeeze film bearings, parallel surface bearing, step bearings, hydrodynamic instability, stiffness and damping coefficients, stability.	9
Unit IV - Externally pressurized oil bearings, circular step bearings, rectangular thrust bearings, opposed pad bearings, multi races bearings, gas lubricated bearings, governing equations, infinitely long plane slider bearings, infinitely long journal bearings, finite journal bearings, externally pressurized gas bearings, porous gas bearings, elasto-hydrodynamic lubrication, dimensionless parameters, film thickness equations.	9
Unit V – Ball bearings, deep groove radial bearings, angular contact bearings, thrust ball bearings, surface roughness on hydrodynamic bearings and elasto-hydrodynamic line contacts, derivation of average Reynolds equation for partially lubricated surface, effect of surface roughness on journal bearings.	9

LIST OF TUTORIALS: Tutorials based on above syllabus.

References:

Text Books:

1. Principles in Tribology, Edited by J. Halling, 1975
2. Hydrostatic Lubrication, Bassani R. and Piccigallo B., Elsevier Publication.
3. Bernard J. Hamrock, "Fundamentals of Fluid Film Lubrication", McGraw Hill Publication
4. Tribology in Machine Design, Stolarski T.A., Butterworth Heinemann, Oxford

Reference Books Recommended:

1. S.K. Basu, B. B. Ahuja, S. N. Sengupta , "Fundamentals of Tribology", EEE, PHI Pvt. Publications Ltd.
2. A. Cameron, "Basic Lubrication Theory", Ellis Horwood Ltd, 1981.
3. Friction and Lubrication of Solids, Bowden F.P. and Tobor D., Clarendon Press, Oxford.
4. An Introductory Guide to Industrial Tribology, Denis Summers, Smith J., Mechanical Engineering Publication, London.
5. Handbook of Tribology, Bharat Bhushan & Gupta B.K., McGraw Hill.

RTM Nagpur University- Mechanical Engineering
6th Semester-Elective-II
Tool Design –(BEME605T)
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-II)	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:

1. Fundamentals of the Tool Design, ASTME, Prentice-Hall of India Private Ltd., New Delhi.
2. Manual of Jigs and Fixtures Design, Henrickson, Industrial Press Inc., New York.

RTM Nagpur University- Mechanical Engineering
6TH SEM-(Elective II)
Advanced Manufacturing Techniques-BEME605T
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	Advanced Manufacturing Techniques (Elective II)	3	0	0	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
6th Semester-Elective-II
CNC & Robotics –(BEME605T)
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	CNC & Robotics **(**Elective-II)	03	-	--	3	30	70	100	03

Sr. No.	Course Objective The objective of this course is–
1	Understand NC, CNC and DNC manufacturing. Evolution and principle of CNC machine tools and different measurement technologies
2	Generate manual part program for CNC machining.
3	To introduce the functional elements of Robotics
4	Concept of industrial robotics and its various applications.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Understand fundamentals of NC, CNC and DNC.
CO2	Understand basic drives and work holding devices used in CNC
CO3	Understand NC programming.
CO4	Understand history and classification of robots
CO5	Understand Robot end effectors, motion control, programming languages and applications

Syllabus -CNC & Robotics (Elective II), 6th Sem, Mechanical Engineering	
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 center and Turning center, of CNC Machines. ,	08
Unit II: Drives and work holding devices:- Spindle drives – DC shunt motor, 3 phase AC induction motor, feed drives –stepper motor, servo principle, DC and AC servomotors, Axis measuring system – synchro, synchro-resolver, gratings, moiré fringe gratings, encoders, inductosysn, laser interferometer, work holding devices for rotating and fixed work parts, economics of CNC, maintenance of CNC machines ,	08
Unit III: Programming CNC machines, Part print analysis and Process planning, Advanced Programming features ,Canned cycles, Subroutines, Macros, special cycles etc. APT part programming using CAD/CAM, Parametric Programming. Manual part programming for CNC turning, milling and machining center. Computer assisted part programming techniques , Conversational and Graphics based software, Solids based part programming. Freeform surface machining. Simulation and Verification of CNC programs. ,	09
Unit IV: Robot anatomy, robot configuration, motions joint notation work volume, robot drive system, control system and dynamic performance, precision of movement. Robot activation and feedback components. motion analysis and control: Manipulator kinematics, position representation forward transformation, homogeneous transformation, manipulator path control, robot dynamics, configuration of robot controller. End effectors: Grippers-types, operation, mechanism, force analysis, tools as end effectors consideration in gripper selection and design. SENSORS: Desirable features, tactile, proximity and range sensors, uses sensors in robotics. Positions sensors, velocity sensors, actuators sensors, power transmission system. ,	09
Unit V ROBOT PROGRAMMING: Lead through programming, Robot programming as a path in space, Motion interpolation, WAIT, SINONAL AND DELAY commands, Branching capabilities and Limitations. ROBOT LANGUAGES: Textual robot Languages, Generation, Robot language structures, Elements in function. ROBOT APPLICATION: Material transfer, Machine loading/unloading. Processing operation, Assembly and Inspection, Feature Application. Machine vision: Functions, Sensing and Digitizing-imaging, Devices, Lighting techniques, Analog to digital single conversion, image storage, Image processing and Analysis-image. ,	09

References:

Text Books Recommended:

1. Krar, S., and Gill, A., "CNC Technology and Programming", McGraw Hill publ Co, 1990.
2. Lynch, M., "Computer Numerical Control for Machining", McGraw Hill, 1992.
3. Koren Y, "Computer Control of Manufacturing Systems", McGraw, 1986.
4. Fu K.S., Gonzalez R.C., and Lee C.S.G.," Robotics control, sensing, vision, and intelligence", McGraw-Hill Book Co., 1987.
5. Klafter R.D., Chmielewski T.A. and Negin M.," Robot Engineering An Integrated approach", Prentice Hall of India, New Delhi, 1994.

Reference Books Recommended:

1. Gibbs, D., "An Introduction to CNC Machining", Casell, 1987.
2. Seames, W.S., "Computer Numerical Control Concepts and Programming", Delmar Publishers, 1986.

RTM Nagpur University- Mechanical Engineering
6th Sem-(Elective-II)
Design of Heat Exchangers –(BEME605T)
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	**Elective-II Design of Heat Exchangers**	03	-	-	03	30	70	100	03 Hours

Prerequisites: Engineering Thermodynamics, Fluid Mechanics, Heat Transfer

Sr. No.	Course Objective The objective of this course is–
1	To provide exposure to different kind of heat exchanger, their working and selection for a given application.
2	To analyze the sizing and rating of the heat exchangers for various applications
3	To explain construction and thermal design methodology for Heat Exchangers and use computational tools for designing.
4	To explore different techniques of heat exchanger analysis and evaluate the performance characteristics.
Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Understand the basic design methodologies for heat exchanger, different techniques of heat exchanger analysis and be aware of common heat exchangers with their constructions and working principles
CO2	Learn how to design common types of heat exchangers; namely shell-and-tube, tube and tube, compact heat exchanger and heat pipes micro heat exchangers and double pipe heat exchangers etc.
CO3	Select various TEMA standards and software tool in the designing of different types of heat exchanger.
CO4	Formulate the mathematical model for heat exchanger
CO5	Apply the various concepts to design Direct contact heat exchangers (cooling towers) & Condensors and evaluate the performance of cooling tower

SYLLABUS Design of Heat Exchangers-(Elective-II)	
Contents	No of hours
Unit I: **Different classification and basic design methodologies for heat exchanger:** Classification of heat exchanger, selection of heat exchanger, overall heat transfer coefficient, LMTD method for heat exchanger analysis for parallel, counter, multi-pass and cross flow heat exchanger, e-NTU method for heat exchanger analysis, fouling, cleanliness factor, percent over surface, techniques to control fouling, additives, rating and sizing problems, heat exchanger design methodology.	10
Unit II: **Design of double pipe heat exchangers:** Thermal and hydraulic design of inner tube and annulus, hairpin heat exchanger with bare and finned inner tube, total pressure drop. **Design of compact heat exchangers:** Plate fin heat exchanger, tube fin heat exchanger, heat transfer and pressure drop.	9
Unit III: **Design of Shell & tube heat exchangers:** Basic components, basic design procedure of heat exchanger, TEMA standard heat-exchanger nomenclature, TEMA code, standards selection criteria for different types of shells and front and rear head ends; geometrical characteristics of TEMA heat exchangers. J-factors, conventional design methods, Kerns method ,Bell-Delaware method.	08
Unit IV: **Direct contact heat exchangers (cooling towers) & Condensers:** Design considerations for Condensers, Evaporators, Cooling Tower etc. Design of surface and evaporative condensers, Cooling tower Packing's, Spray design, Selection of pumps, Fans and Pipes, Testing ,Maintenance, and performance characteristics of cooling tower	08
Unit V: **Heat Transfer Enhancement and Performance Evaluation:** Enhancement of heat transfer, Performance evaluation of Heat Transfer Enhancement technique. Introduction to pinch analysis. Review of mechanical Design, Materials of Construction, corrosion damage, testing and inspection. Use of Software in heat exchanger design, Introduction to Heat pipes and micro Heat Exchanger	09

Sr. No.	List of Tutorials
01	Introduction and classification of Heat Exchangers
02	Basic Design Methods of Heat Exchanger
03	Shell And Tube Heat Exchanger
04	Compact and Plate Heat Exchanger
05	Direct contact heat exchangers (cooling towers) & Condensors:
06	Analysis of heat exchangers

References:

Text Books Recommended:

1. SadikKakac and Hongtan Liu, "Heat Exchangers Selection", Rating and Thermal Design, CRC Press, 2002.
2. Shah,R. K., Dušan P. Sekulić, "Fundamentals of heat exchanger design", John Wiley & Sons, 2003.
3. Advances in thermal design of heat exchangers: a numerical approach: direct-sizing, step-wise rating, and transients, Eric M. Smith, John Wiley & Sons, 1999.
4. Cooling Tower, Nicholas Cheremistoff, Ann Arbor Science Pub 1981
5. J.P. Gupta, Fundamentals of heat exchangers and pressure vessel technology, Hemisphere publishing corporation, Springer-Verlag (outside NA), 1986
6. Donald Q. Kern and Alban D. Kraus, "Extended surface hear transfer" Mc Graw Hill Book Co., 1972

Reference Books Recommended:

1. Process Heat Transfer, CRC Press, G F Hewuttm G L Shires and T R Bott,1994.
2. Compact Heat Exchangers, Pergamon, J.E. Hesselgreaves, Elsevier science Ltd 2001.
3. Advances in Thermal Design of Heat Exchangers, Eric M Smith, John Wiley & Sons, Ltd., 2005.
4. Heat Exchanger Design, P. O. Fraas, John Wiley & Sons, 1988

Data Books Recommended:

1. Heat exchanger design hand book, Kuppan. T., New York : Marcel Dekker, 2000.
2. Handbook for Heat Exchangers and Tube Banks Design, D. Annaratone , Springer Verlag, 2010.
3. Heat Exchanger Design Hand Book, Schunder E.U, Hemisphere Pub.

RTM Nagpur University- Mechanical Engineering
6th Sem-(Elective-II)
Advanced I C Engines –(BEME605T)
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	Advance IC Engines [Elective – II]	3	-	-	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	To enable the students understand various working cycles, basic components of IC engine, cooling, lubrication and Fuel supply system of IC engine.
2	To enable the students to familiarize with combustion (normal and abnormal) phenomenon in SI and CI engine.
3	To update the knowledge in Alternate fuel, engines exhaust emission and engine testing.
4	To enable the students to understand recent advancement used in IC engine.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Understand basics of IC Engine, types of IC Engine, working cycle, cooling and lubrication system
CO2	Understand basic fuel, Alternate fuels and fuel supply system in IC engine
CO3	Understand combustion phenomenon in in SI and CI engine.
CO4	Understand the various performance parameters of an engine, testing procedure and its analysis.
CO5	Illustrate emission norms its emission control for engine. Comprehend the different technological advances in engines.

Syllabus- Advanced I C Engines-(Elective-II)	
Contents	No of hours
Unit I :*Basics of IC Engine and its operation:* Introduction, Definition and Function of IC Engine, Various nomenclature of IC Engine, Classification of IC Engine, Engine components and their material, Working of Otto cycle, Diesel cycle and dual cycle on basis of PV Diagram, Theoretical and actual valve timing diagram of 4-Stroke SI and CI Engine, Comparison of SI and CI engines, comparison of two stroke and four stroke Need,requirement and types of Engine cooling lubrication and system.	**[8 Hrs.]**
UNIT – II: *Fuels and its supply system for SI and CI engine:* Important qualities of SI and CI engine fuels, Rating of SI & CI engine fuels, Mixture requirement for different loads and speeds, Alternative fuels used for IC engine (Ethanol, Methanol, Hydrogen, LPG, CNG, Bio gas and Bio-diesel, Hybrid vehicle). SI engine Fuel supply system- Types of fuel supply used, working of simple carburetor and its limitations, Gasoline Injection -advantages and disadvantages. Types of Gasoline Injection – TBI, MPFI, GDI, C.I. Engine Fuel supply system-components of Fuel injection system., D.I. systems and CRDI , types of nozzles. (Numerical on carburetor and fuel injection system)	**[8 Hrs.]**
UNIT – III: *Combustion in S.I. Engine:* Introduction, Stages of combustion in SI Engine, flame front propagation, factors affecting flame front propagation, Abnormal combustion in SI Engine, Factor responsible for abnormal combustion and its control. *Combustion in C. I. Engines:* Charge motion within the cylinder, Air swirl, Methods to generate air swirl, Stages of combustion in C. I. engines, Ignition delay period, factors affecting delay period, Abnormal combustion CI Engine, Factor responsible for abnormal combustion and its control. Importance of supercharging and turbocharging in IC engines.	**[10 Hrs.]**
UNIT IV: *Engine performance parameter and Testing:* Definitions of important engine characteristics of engines Brake, Torque & Power, Mechanical efficiency, Mean effective pressure, Specific fuel consumption and efficiency, Volumetric efficiency. Testing - Measurement of friction power, indicated power (indicator diagram), Brake power, various types of absorption dynamometer, Fuel consumption measurement, Air consumption measurement methods, Engine efficiencies. Variables affecting engine performance characteristics. Heat balance sheet.	**[8 Hrs.]**

UNIT V: *Engine emission and Electronic Engine Controls system:* Constituents of exhaust emission. Factors responsible for formation of NOx, HC, CO and particulate emissions, Methods of controlling emission, Exhaust-Gas recirculation (EGR), Evaporation emission control system. After exhaust treatment system - Secondary air injection system, Catalytic converter. Introduction to Euro norms and Bharat Stage norms, Diesel smoke and its control, Comparison of SI and CI emission. Effect of engine emission on environment and human health. Electronic Control module (ECM),Inputs and output signals of ECM, Various Sensors -Throttle Position, Inlet Air Temperature, Coolant Temperature, Crankshaft Position, Camshaft Position, Mass Air flow ,Manifold absolute pressure , Oxygen sensors their function construction and importance.	**[8 Hrs.]**

Sr. No.	List of Tutorials
01	Introduction, IC engine history and development.
02	Study of cooling and lubrication systems of IC engine.
03	Numerical on fuel supply system of IC engine.
04	Discussion on combustion in SI and CI engine.
05	Numerical on engine testing
06	Discussion on emission, emission norms.

References:

Text Books Recommended:

1. **TEXT BOOKS:**

1. Internal Combustion Engines, M. C. Mathur, R.D. Sharma, Dhanpat Rai & Sons.
2. Internal Combustion Engine, R.K. Rajput, Laxmi Publications.
3.Internal Combustion Engines, V. M. Domkundwar, Dhanpat Rai & Sons.
4. Internal Combustion Engines, V. Ganesan, Tata McGraw Hill.
5. Fundamentals of Internal Combustion Engines, H.N. Gupta, PHI Learning.

Reference Books Recommended:

REFERENCE BOOKS:

1. Internal Combustion Engine Fundamentals, John B. Heywood, Tata McGraw Hill.
2. Internal Combustion Engines and Air pollution, Edward F. Obert, Intex Educational.
3. Automobile Engineering Vol.-2, Dr. Kirpal Singh, Standard Publishers.
4. Automobile Mechanics, Crouse & Anglin, Tata McGraw Hill.
5. I.C. Engine Combustion & Emission, Pundir B.P., Narosa publication.

RTM Nagpur University-Mechanical Engineering
6th Semester
Skill Development -(BEME606P)
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	**Skill Development**	-	-	4	02	50	--	50	3

Sr. No.	Course Objective The objective of this course is–
1	Apply engineering knowledge, critical thinking, creativity, and problem solving skills with integrity and inclusivity in professional engineering practice
2	Continue intellectual development through graduate education, professional development courses, self-directed investigation, and/or on-the-job training and experience.
3	Embrace leadership and collaborative roles in their careers

Course Outcomes

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

[1] Apply knowledge of mathematics, science, and engineering to mechanical engineering problems.
[2] An ability to design and conduct experiments, as well as to analyze and interpret data.
[3] An ability to design systems, components, or processes to meet desired needs.
[4] An ability to function on multi-disciplinary teams.
[5] An ability to identify, formulate, and solve engineering problems.
[6] An understanding of professional and ethical responsibility.
[7] An ability to communicate effectively with written, oral, and visual means.
[8] The broad education necessary to understand the impact of engineering solutions in a global and societal context.
[9] A recognition of the need for and an ability to engage in life-long learning.
[10] A knowledge of contemporary issues.
[11] An ability to use modern engineering techniques, skills, and computing tools necessary for engineering practice.
[12] An ability to work professionally in either thermal or mechanical systems areas.

Syllabus-6th Semester, Mechanical , Skill Development
Technical Skills

1. Use of Lab Equipment

- Perform testing.
- Equipment familiarization
- Learn to use the equipment and what type of data can be obtained from it.
- To get this experience from internships, lab courses, and working in a professor's research lab.

2. Statistics and Data Analysis

- Use of Minitab

3. Computer Software Skills

- SOLIDWORKS
- Excel

4. Part, Process, and Product Design

- Understanding the New Product Development
- Manufacturing,
- Product design,
- Quality

5. Test Method Development

6. Technical Writing

- Technical reports
- Test methods
- Lab notebooks
- Work instructions
- Emails

7. Create and Read Technical Drawings

- Computer-aided design (CAD)

8. Problem-solving Skills

- The challenges can range from technical issues to people management.
- Students need to identify, assess, take action, and resolve obstacles.

9. Mechanical Aptitude

10. Knowledge of a Specific Topic

Soft Skills

1. Leadership Skills
2. Time Management
3. Effective Communication
4. Attention to Detail
5. Resourcefulness (How to take help of)
    a. Clubs relating to your major
    b. Colleagues and upperclassmen
    c. Professors and teaching assistants
    d. On-campus resources, such as tutoring centers
    e. Blogs and websites
6. Decision-making Skills
7. Negotiating Skills
8. Public Speaking Skills
9. Perseverance
10. Attitude and Motivation:
11. Ability to Work Independently and With a Team
12. Ability to Give and Receive Feedback
13. Adaptability Skills

RTM Nagpur University-Mechanical Engineering
6th Semester
Summer Internship -(BEME607P)

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	Summer Internship	-	-	--	--	--	--	--	-

Sr. No.	Course Objective The objective of this course is–
1	An internship is an official program offered by organizations to help train and provide work experience to students and recent graduates. Internships play a crucial role in shaping one's career. It not only helps undergraduates and graduates gain real exposure to working environments but also helps them develop the necessary skills required to stand out in a saturated job market.
2	a) Experience a professional working environment b) Receive Credits for College c) Interns are potential candidates for a new hire d) Build your resume with hard and soft skills e) Learn time management f) Make industry contacts g) Build and practice new skills

Course Outcomes

1. Internships provide exposure to the real world
2. Internships give a platform to establish critical networking connections
3. Internships allow to learn more about yourself
4. Internships equip with more than just technical skills
5. Internships allow to gain a competitive edge

6th Sem, Mechanical , Summer Internship

Students are expected to

1. **Assist and contribute to the team**

Here are some day-to-day intern roles and their responsibilities:

- Performing clerical duties:
- Creating PowerPoint presentations,
- Drafting reports,
- Designing creative,
- Researching trends

2. **Managing social media and emails:** Students may be asked to handle the company's social media accounts, write emails to customers, talk to clients on the phone, and similar duties. It may include designing social media posts, scheduling them and creating a general strategy for your posts.

Event handling: Interns may be asked to oversee the scheduling of important events. Also they may asked to help get everything prepared for an important

Research: Interns fresh from a university education have a great deal of up-to-date knowledge. Organizations may put this knowledge to good use by placing you in a research role. Students may be asked to look into a new project and give your recommendations on how best to execute it.

3. **Learn and gain experience**

Picking up hard skills: Hard skills are the technical skills needed to carry out intern responsibilities, and eventually job duties, successfully.

- Soft skills: Ability to relate to people and build mutually-beneficial relationships.
- Emotional intelligence,
- Motivation, people-skills,
- Listening, Communication.

4. **Job shadow**

As the name suggests, the practice involves "shadowing" someone as they perform their daily duties, observing their activities, and learning what the role entails via indirect experience.

5. **Take on an increasing amount of responsibility**
6. **Network**

While networking isn't an official requirement as such, it might as well be. Networking involves building relationships with bosses, colleagues, and customers and clients.

7. **Make a career call**

RTM Nagpur University- Mechanical Engineering
6th Semester (Mandatory Course)
Environmental Studies –(BEME608T)
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	**Environmental Studies**	00	-	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:

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