RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR

Faculty of Science & Technology

Course Scheme and syllabus of Bachelor of Technology

7th and 8th semester (Mechanical Engineering)

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

Sr No	Course Code	Category	Course Title	Teaching Scheme			Credits	Examination Scheme								
								Theory					Practical			
				L	T	P		Duration of Exam (Hrs)	Max. Marks College Assessment	Max. Marks University Assessment	Total Marks	Min. Passing Marks	Max. Marks College Assessment	Max. Marks University Assessment	Total Marks	Min. Passing Marks
1		Basic Science course	Mathematics - I	3	1	-	4	3	30	70	100	45	-	-	-	-
2		Basic Science course	Applied Physics	3	1	-	4	3	30	70	100	45	-	-	-	-
3		Engineering Science Courses	Engineering Graphics	1	-	-	1	2	15	35	50	23	-	-	-	-
4		Engineering Science Courses	Energy & Environment	3	-	-	3	3	15	35	50	23	-	-	-	-
5		Humanities, Social Sciences & Management courses	Communication & Aptitude Skills	2	-	-	2	-	15	35	50	23	-	-	-	-
6		Engineering Science Courses	Basics of Civil & Mechanical	4	-	-	Audit (0)	-	50	-	50	-	-	-	-	-
7		Basic Science course	Applied Physics Lab	-	-	2	1	-	-	-	-	-	25	25	50	25
8		Engineering Science Courses	Engineering Graphics Lab	-	-	4	2	-	-	-	-	-	25	25	50	25
9		Engineering Science Courses	Energy & Environment Lab	-	-	2	1	-	-	-	-	-	25	25	50	25
10		Humanities, Social Sciences & Management courses	Communication Skills Lab	-	-	2	1	-	-	-	-	-	25	25	50	25
11		Mandatory Course	Induction Program	Three Weeks			-	-	-	-	-	-	-	-	-	-
Total				**16**	**2**	**10**	**-**	**-**	**155**	**245**	**400**	**-**	**100**	**100**	**200**	**-**
Semester Total				**28**			**19**	**Marks 600**								

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

Sr No	Course Code	Category	Course Title	Teaching Scheme (Hours/Week)			Credits	Examination Scheme								
								Theory					Practical			
				L	T	P		Duration of Exam (Hrs)	Max. Marks College Assessment	Max. Marks University Assessment	Total Marks	Min. Passing Marks	Max. Marks College Assessment	Max. Marks University Assessment	Total Marks	Min. Passing Marks
1		Basic Science course	Mathematics -II	3	1	-	4	3	30	70	100	45	-	-	-	-
2		Basic Science course	Applied Chemistry	3	1	-	4	3	30	70	100	45	-	-	-	-
3		Engineering Science Courses	Advance Engineering Materials	3	-	-	3	2	15	35	50	23	-	-	-	-
4		Engineering Science Courses	Engineering Mechanics	2	-	-	2	2	15	35	50	23	-	-	-	-
5		Engineering Science Courses	Basic Electrical Engineering	2	-		2	2	15	35	50	23	-	-	-	-
6		Engineering Science Courses	Computational Skills	2	-		2	2	15	35	50	23	-	-	-	-
7		Basic Science course	Applied Chemistry Lab	-	-	2	1	-	-	-	-	-	25	25	50	25
8		Engineering Science Courses	Advance Engineering Materials Lab	-	-	2	1	-	-	-	-	-	25	25	50	25
9		Engineering Science Courses	Workshop Practices	-	-	4	2	-	-	-	-	-	25	25	50	25
10		Engineering Science Courses	Computational Skills Lab	-	-	2	1	-	-	-	-	-	25	25	50	25
11		Mandatory Course	Indian Culture and Constitution	2	-	-	Audit (0)	-	-	-	-	-	-	-	-	-
Total				**17**	**2**	**10**	-	-	**120**	**280**	**400**	-	**100**	**100**	**200**	-
Semester Total				**29**			**22**	**Marks 600**								

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur

Faculty of Science & Technology

Scheme of Examination and Evaluation

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

III Semester B. Tech (Mechanical Engineering)

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

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

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

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

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

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

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

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur

Faculty of Science & Technology

Scheme of Examination and Evaluation

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

VII Semester B. Tech (Mechanical Engineering)

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

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

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

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

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

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

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur

Faculty of Science & Technology

Scheme of Examination and Evaluation

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

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

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

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

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

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

Course Outcomes

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

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

SYLLABUS

Contents	No of hours
Unit I **Sensors and Transducers-** Types and its Application, Scope and Elements of Mechatronics, Mechatronics design process, Measurement system, Requirements and types of control systems, feedback principle, Basic elements of feedback control systems, Classification of feedback control system, Example of any one Mechatronics Systems in detail	7

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

References:

Text Books Recommended:

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

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

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

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

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

List of Practical's

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

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

Suggested References:

Text Books Recommended:

1. Mechatronics - Integrated Mechanical Electronics System, K.P. Ramachandran, Wiley India Pvt. Ltd. New Delhi
2. Mechatronics & Microprocessors, K.P. Ramachandran, Wiley India Pvt. Ltd., New Delhi.
3. Programmable Logic Controllers, John W Webb and Ronald A Reis, Prentice Hall, Inc., 1999.
4. Mechatronics, Bolton W, Pearson Education, Second Edition, 1999.
5. Pneumatic Application, Kemprath Reihe, Wemer Depper and Kurt Stoll, Vogel Buch Verlag Wurzbutg, 1987.
6. An Introduction to MEMS Engineering, Nadim Maluf & Kirt Willams.
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2. Pneumatic Tips, Festo K G, Festo, Germany, 1987.
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4. Mechatronic Systems Fundamentals, Rolf Isermann, Springer, 2003.
5. Mechatronics: Introduction, Robert H Bishop, Taylor and Francis, 2006.
6. Mechatronics System Design, D. Shetty, Cengage Learning (Indian Ed.)

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

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

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

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

References:

Text Books Recommended:

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

Reference Books Recommended:

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

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

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

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

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

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

Suggested References:

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

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

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

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

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

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

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

References:

Text Books Recommended:

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

Reference Books Recommended:

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

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

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

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

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

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

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

Suggested References:

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

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

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

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

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

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

References:

Text Books Recommended:

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

Reference Books Recommended:

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

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

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

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

List of Practical

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

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

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

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

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

References:

Text Books Recommended:

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

Reference Books Recommended:

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

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

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

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

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

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

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

References:

Text Books Recommended:

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

Reference Books Recommended:

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

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

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

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

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

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

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

References:

Text Books Recommended:

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

Reference Books Recommended:

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

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

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

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

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

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

References:

Text Books Recommended:

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

Reference Books Recommended:

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

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

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

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

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

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

References:

Text Books Recommended:

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

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

Reference Books Recommended:

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

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

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

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

Course Outcomes

At the end of the course students will be able to

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

Syllabus Open Elective – II: Introduction to Renewable Energy Resources

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

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

References

Text Books Recommended:

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

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

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

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

Reference Books Recommended:

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

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

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

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

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

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

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

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

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

References:

Text Books Recommended:

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

Reference Books Recommended:

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

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

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

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

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

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

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

Students should be given training on

1.Technical aptitude

2.General aptitude

3.Group Discussion

4.Interview Techniques

To enhance their chances of employment.

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

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

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

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

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

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

References:

Text Books Recommended:

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

.

Reference Books Recommended:

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

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

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

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

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

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

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

References:

Text Books Recommended:

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

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

Reference Books Recommended:

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

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

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

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

List of Practical

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

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

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

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

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

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

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

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

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

References:

Text Books Recommended:

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

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

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

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

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

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

Reference Books Recommended:

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

2Computer Control of Manufacturing Systems 2005 Koren Mcgraw Hill

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

4Cellular Manufacturing Systems Irani, S.A Hand Book

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

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

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

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

List of Practical

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

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

Suggested References:

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

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

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

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

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

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

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

References:

Text Books Recommended:

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

Reference Books Recommended:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

References:

Text Books Recommended:

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

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

3 An Introduction to CNC Machining Gibbs, DCasell, 1987

.

Reference Books Recommended:

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

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

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

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

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

List of Practical's

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

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

Suggested References:

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

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

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

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

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

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

References:

Text Books Recommended:

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

Reference Books Recommended:

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

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

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

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

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

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

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

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

References:

Text Books Recommended:

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

Reference Books Recommended:

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

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

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

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

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

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

References:

Text Books Recommended:

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

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

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

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

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

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

References:

Text Books Recommended:

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

Reference Books Recommended:

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

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

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

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

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

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

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

References:

Text Books Recommended:

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

Reference Books Recommended:

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

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

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

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

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

References:

Text Books Recommended:

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

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

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

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

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

Reference Books Recommended:

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

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

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

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

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

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

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

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

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

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

References:

Text Books Recommended:

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

Reference Books Recommended:

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

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

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

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

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

References:

Text Books Recommended:

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

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

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

Reference Books Recommended:

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

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

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

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

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