DEPARTMENT OF TECHNOLOGY
SHIVAJI UNIVERSITY, KOLHAPUR

STRUCTURE AND SYLLABUS
OF
THIRD YEAR B. TECH.
(MECHANICAL ENGINEERING)

TO BE EFFECTIVE FROM
ACADEMIC YEAR 2018-19

B. Tech. Programme in Mechanical Engineering

1. Vision

To be a premier centre of engineering education and industrial research that provides excellent academic ambience and nurtures innate talents of students to become technically sound, application oriented, innovative and successful mechanical engineers

2. Mission

To empower students with the fundamentals of Mechanical Engineering through innovative curriculum and effective teaching thereby enabling them for successful career by imparting knowledge, skills and right attitude and a spirit to serve the society with professional ethics.

3. Program Educational Objectives (PEO)

Graduate should:

1. Demonstrate successful professional careers with strong fundamental knowledge in Science, Mathematics, English and Engineering Sciences so as to enable them to analyze the Mechanical Engineering related problems leading to leadership, entrepreneurship or pursuing higher education
2. Acquire technical knowledge in specialized areas of Mechanical Engineering such as Materials, Design, Manufacturing and Thermal Engineering with a focus on research, innovation and gaining the technical skills in advanced software packages.
3. Work with multidisciplinary field of engineering and technology to enlarge the ability among the students to understand the different industrial environments.
4. Continuously learn, research and develop with strong professional, moral and ethical values and with a zeal for life-long learning.

4. Program Outcomes (PO)

An engineering graduate of Mechanical Engineering Programme at Department of Technology by the time of graduation will achieve and demonstrate:

a) An ability to apply basic knowledge of science, mathematics and engineering fundamentals in the field of Mechanical Engineering.

b) An ability to identify, formulates, review research literature and analyze mechanical engineering problems using basics principles of science, mathematics and engineering.

c) An ability to design for complex mechanical engineering problems using basic design concepts, analyze and process to meet the desired needs with in realistic constraints such as manufacturability , durability, sustainability and economy with appropriate consideration for the public health, safety, cultural, societal, and environmental considerations.

d) An ability to design and conduct experiments using research-based knowledge and methods including design of experiments, analyze, interpret the data and results with valid conclusion.
e) An ability to apply the modern tools and apply appropriate techniques to synthesize, model, design, analyze, verify and optimize to solve complex mechanical engineering problems within defined specification by using suitable modern tools to satisfy the needs of the society within realistic constraints such as social, economical, political, ethical, health, safety and manufacturing.
f) An ability to understand the impact of mechanical engineering solutions globally, in terms economic, societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g) An ability to understand the principles, commitment and practice to improve product sustainable development globally in mechanical engineering with minimal environmental effect.
h) An ability to understand and apply ethical principles and commitment to address professional ethical responsibilities of an engineer.
i) An ability to function efficiently as an individual and as a group member in a team in multidisciplinary activities
j) An ability to communicate, comprehend and present effectively with engineering community and the society at large on complex engineering activities by receiving clear instructions for preparing effective reports and design documentation.
k) An ability to acquire and demonstrate the knowledge of contemporary issues related to finance and managerial skills to bring up entrepreneurs and entrepreneurship.
l) An ability to recognize and adapt to emerging field of application in engineering and technology by developing self-confidence for continuing education and lifelong learning process.

5. Programme Specific Outcomes (PSO)

m) The Mechanical Engineering Graduates will be able to function in various domains of manufacturing industry in the areas of foundry, jigs fixtures, forming processes, quality control, production management and industrial engineering.
n) The Mechanical Engineering Graduates will be able apply the skills of advanced software tools.
o) The Mechanical Engineering Graduates will be able to work in automobile industry, power plants, energy technology in the sphere of operation and maintenance.

DEPARTMENT OF TECHNOLOGY

THIRD YEAR B.TECH

Scheme of Teaching and Examination

Semester – V (Mechanical Engineering)

To be implemented from Academic Year 2018-19

Sr. No	Subject	Teaching Scheme (Hours / Week)				Examination Scheme (Marks)					
						Theory			Practical		
		L	T	P	Credits	Scheme	Max. marks	Min. Passing	Scheme	Max. marks	Min. Passing
1.	Machine Design – I	04	-	-	04	CIE	50	20	--------	-------	--------
						SEE	50	20	--------	-------	--------
2.	Theory of Machines – II*	04	-	-	04	CIE	50	20	--------	-------	--------
						SEE	50	20	--------	-------	--------
3.	Energy Engineering	03	-	-	03	CIE	50	20	--------	-------	--------
						SEE	50	20	--------	-------	--------
4.	Manufacturing Engineering. – II**	04	-	-	04	CIE	50	20	--------	-------	--------
						SEE	50	20	--------	-------	--------
5.	Heat and Mass Transfer	03	-		03	CIE	50	20	--------	-------	--------
						SEE	50	20	--------	-------	---------
6.	**Laboratory** Theory of Machines – II	-	-	02	01	------	-------	--------	EOE	50	20
7.	**Laboratory** CAD	-	-	02	01	------	-------	--------	EPE	50	20
8.	**Laboratory** Workshop Practice– III	-	-	02	01	------	-------	--------	EPE	50	20
9.	**Laboratory** ***Internship – I and Mini Project	-	-	01 01	02	-----	-------	--------	IOE	50	20
10.	**Laboratory** Heat and Mass Transfer	-	-	02	01	------	-------	--------	EPE	50	20
11.	**Laboratory** Manufacturing Engineering - II	-	-	02	01	------	--------	--------	EOE	50	20
	Total	18	-	12	25	------	**500**	--------	--------	**300**	--------
AUDIT COURSE											
12.	Research Methodology (Audit Course)	01	-	02	--	------	-------	--------	-----	----	---

Total Credits: 25 Total Contact Hours/Week: 30 hrs

Note:

#: Minimum 40% marks must be secured in SEE to pass that head.

- Tutorials and practical shall be conducted in batches with batch strength not exceeding 18 students.

*- Theory of Machine – II: The duration of this paper shall be of 4 Hours and shall include drawing of Cam-Follower on separate drawing sheet.

**- Manufacturing Engineering – II: The duration of this paper shall be of 4 Hours and shall include drawing of jigs and fixture / press tools problem on separate drawing sheet.

***Internship – I and Mini Project** shall include

a. Internship of minimum four (4) weeks should be done after SY (Semester IV) in summer vacation and it's assessment will be done in TY (Semester V) based on report submitted. – Credit 01
b. Executing a mini project and delivering a presentation with mini project report.- Credit 01

Work load of the assessment both (a) and (b) shall be assigned to the mini project seminar guide.

CIE – Continuous Internal Evaluation, SEE – Semester End Examination,
IPE – Internal Practical Evaluation, EPE–External Practical Examination,
IOE– Internal Oral Evaluation, EOE–External Oral Examination

Note: There will be an industrial tour/ visit based on the course requirement during semester V. The report of the visits during the tour is required to be submitted by the students.

DEPARTMENT OF TECHNOLOGY
THIRD YEAR B.TECH
Scheme of Teaching and Examination
Semester – VI (Mechanical Engineering)

To be implemented from Academic Year 2018-19

Sr. No	Subject	Teaching Scheme (Hours / Week)				Examination Scheme (Marks)					
						Theory			Practical		
		L	T	P	Credits	Scheme	Max. marks	Min. Passing	Scheme	Max. marks	Min. Passing
1.	Machine Design – II	04	-	-	04	CIE	50	20	--------	-------	--------
						SEE	50	20	--------	-------	--------
2.	Control Engineering	04	-	-	04	CIE	50	20	--------	-------	--------
						SEE	50	20	--------	-------	--------
3.	Internal Combustion Engines	04	-	-	04	CIE	50	20	--------	-------	--------
						SEE	50	20	--------	-------	--------
4.	Metrology and Quality Control	04	-	-	04	CIE	50	20	--------	-------	--------
						SEE	50	20	--------	-------	--------
5.	Industrial Engineering and Management	03	01	-	04	CIE	50	20	--------	-------	--------
						SEE	50	20	--------	-------	---------
6.	**Laboratory** Metrology and Quality Control	-	-	02	01	--------	-------	--------	EOE	50	20
7.	**Laboratory** Internal Combustion Engines	-	-	02	01	--------	-------	--------	EPE	50	20
8.	**Laboratory** CAM	-	-	02	01	--------	-------	--------	IOE	50	20
9.	**Laboratory** Machine Design - II	-	-	02	01	--------	-------	--------	IOE	50	20
						--------	-------	--------	EOE	50	20
10.	**Seminar**	-	-	02	01	--------	-------	--------	IOE	50	20
	Total	**19**	**01**	**10**	**25**	--------	**500**	--------	--------	**300**	--------
AUDIT COURSE											
11.	Introduction to Foreign Language (Audit Course)	01	-	02	--	--------	-------	--------	-----	----	---

Total Credits: 25 Total Contact Hours/Week: 30 hrs

Note:

#: Minimum 40% marks must be secured in SEE to pass that head.

• Tutorials and practical shall be conducted in batches with batch strength not exceeding 18 students.

Seminar shall include preparing a seminar report of topic of latest technological advancement in chosen area followed by presentation of the seminar. Work load of the assessment shall be assigned to the seminar guide.

CIE – Continuous Internal Evaluation, SEE – Semester End Examination,
IPE – Internal Practical Evaluation, EPE–External Practical Examination,

IOE– Internal Oral Evaluation, EOE–External Oral Examination

Note: There will be an industrial tour/ visit based on the course requirement during semester VI. The report of the visits during the tour is required to be submitted by the students.

Assessment Pattern

Knowledge Level (appropriate combination of levels)	CIE			ESE
	UT-1	UT-2	Course Work	
1. Remember	05	05	Course work of various types enhancing learning of students 6 * 10 marks each. Converted to out of 10.	10
2. Understand	05	05		10
3. Apply	05	05		40
4. Analyze	05	05		20
5. Evaluate	05	05		10
6. Create	05	05		10
Total	**20**	**20**	**10**	**100**

Note: 1. This is general assessment pattern but it may change from course to course. Students are advised to follow the Bloom's Taxonomy.

2. It consists of assignments, quiz, seminars, presentations, research papers and research articles, developing working models, surveys and activities related to course as designed by the course coordinator to suit the needs of the course and to complement programme objectives and outcomes. The practical work and its journal is not part of course work.
3. Students will be given 6 different exercises as mentioned each of 10 marks. The marks scored out of 60 will be converted and rounded to marks out of 10 for final CIE.

Class and Semester	:	**T. Y. B. Tech. (Mechanical Engineering) Part III, Semester V**					
Course Title	:	**MACHINE DESIGN - I**					
Teaching Scheme (Hours)	:	**Lectures 4 hours/weeks=4 x 13 weeks = 52 hours minimum** **Tutorial= -- hour/week** **Practical= -- hours/week**			*Total Credits*	:	**04+00+00 =04**
Evaluation Scheme (Marks)	:	**CIE (20+20) + Course work (10) = SEE = 50**	**IPE=Nil** : **IOE=Nil** : **EPE= Nil** : **EOE = Nil**	**Grand Total=100**	*Duration of SEE*	*:*	**3 hours**
Revision:	:	**First**			*Month*	:	**June 2018**

Pre-requisites **:** In order to complete the course studies successfully, it is important to have a good command of English. Other Pre-requisites include Engineering Physics, strength of materials, Material science etc.

Type of Course **:** Theory

Course Domain **:** Core

Skills Imbibed **:** Cognitive: Recall, Understand, Apply, Analyze, Synthesize, Evaluate
Affective : Awareness, Respond, Value, Organize
Psychomotor: Imitation, manipulation, articulation, naturalization

Course Assessment Methods:

1. Continuous Internal Evaluation: Unit Test I and Unit Test II and Course work.
2. Semester End Examination (SEE).

Course Objectives:

1. To understand fundamental aspects of design.
2. To study design procedures of different mechanical components.
3. To understand stresses and strain induced in the component.
4. To Study the component behavior and failure criteria's of different mechanical components subjected to loads.

Course Outcomes:

1. Formulate the problem by identifying customer needs and convert into design specification.
2. Design of components like shaft, key, coupling, spring, power screw, Knuckle joint, Cotter joint and turn buckle etc.
3. Analyze the stresses and strain induced in the component.
4. Understand component behavior subjected to loads and identify failure criteria.

Curriculum Content	Hours
Unit I: Fundamental aspect of design The meaning of design, Engineering design, Phases of design, design consideration, stress and strain consideration, factor of safety, standardization, preferred series, material selection – weighted point method.	**04**
Unit II: Design against static load Commonly used engineering materials and their important mechanical properties – Cast Iron, Mild Steel, Non-ferrous materials like Aluminum Alloy, Copper and Brass, Stress-strain relationship, stresses due to bending and torsional load, design of cotter, knuckle, Turn-buckle joints, eccentric loading and theories of elastic failure.	**10**
Unit III: Design of Power Screws Forms of Threads, Torque requirement for lifting and lowering load, efficiency of square threaded screw and self-locking screw design of power screws, introduction to re-circulating ball screw**.**	**10**
Unit IV: Design of shafts, keys and couplings Shafts subjected to bending and torsion, types of keys and their design, design of Muff and Clamp coupling.	**10**
Unit V: Design of mechanical springs Design against static conditions, design of compression helical spring, end styles, helical torsion spring, multi leaf spring, Nipping.	**9**
Unit VI: Design of welded joints Types of welded joints, eccentrically loaded joints, and welded joints subjected to bending moment.	**9**

(Note: The course includes numerical treatment on the appropriate modules of various units.)

Text Books

1. Shigley J.E. and Mischke C.R. – "Mechanical Engineering Design" McGraw Hill Publ.Co. Ltd.
2. Bhandari V.B. – "Design of Machine Elements" – Tata McGraw Hill Publ. Co. Ltd.
3. Hall, Holo Wenko and Laughlin, " Theory and problems of machine design, Tata McGraw Hill Publ. Co. Ltd.

Reference Books

1. Spotts M.F. and Shoup T.E. – " Design of Machine Elements" – Prentice Hall International.
2. Black P.H. and O. Eugene Adams – " Machine Design" - McGraw Hill Book Co. Ltd.
3. William C. Orthwein – " Machine Component Design" – West- publishing Co. and Jaico Publ. House.
4. "Design Data" – P.S.G. College of Technology, Coimbatore.
5. Juvinal R.C. – " Fundamentals of Machine Components Design" – John Wiley and Sons.
6. Hall A.S.; Holowenko A.R. and Laughlin H.G. – " Theory and Problems of Machine Design" – Schaum's outline series.

Class and Semester	:	**T. Y. B. Tech. (Mechanical Engineering) Part III, Semester V**					
Course Title	:	**THEORY OF MACHINES - II**					
Teaching Scheme (Hours)	:	**Lectures 4 hours/weeks= 4 x 13 weeks = 52 hours minimum Tutorial= -- hour/week Practical= 02 hours/week**			*Total Credits*	:	**04+00+01 =05**
Evaluation Scheme (Marks)	:	**CIE (20+20) + Course work (10) SEE = 50**	**IPE=Nil IOE=Nil EPE= Nil EOE = 50**	: : :	**Grand Total=100**	*Duration of SEE*	: **4 hours**
Revision:	:	**First**				*Month*	: **June 2018**

Pre-requisites **:** Fundamentals of Mechanical Engineering, Applied Mechanics.

Type of Course **:** Theory

Course Domain **:** Core

Skills Imbibed **:** Cognitive: Recall, Understand, Apply, Analyze, Synthesize, Evaluate
Affective : Awareness, Respond, Value, Organize
Psychomotor: Imitation, manipulation, articulation, naturalization

Course Assessment Methods:

1. Continuous Internal Evaluation: Unit Test I and Unit Test II and Course work.
2. Semester End Examination (SEE)

Course Objectives:

1. To Study and identify type of belt and rope drive for a particular application
2. To Analyze cam geometry and select appropriate cam
3. To Study clutches, brake and dynamometer
4. To Study gyroscopic effects in ships, aero planes, and road vehicles.
5. To Study Understand free and forced vibrations of single degree freedom systems

Course Outcomes:

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

1. Identify and select type of belt and rope drive for a particular application
2. Evaluate cam geometry and select appropriate cam
3. Define clutches, brake and dynamometer and suggest an appropriate use.
4. Characterize balancing as per application requirement.
5. Understand gyroscopic effects in ships, aero planes, and road vehicles.
6. Understand free and forced vibrations of single degree freedom systems

Curriculum Content	Hours
Unit I : Belt Drives Introduction, Type of belts, Tension ratio in belts, Initial tension, Open and cross belt drive, Length of belt, Power transmitted by belt, centrifugal effect on belt, initial tension, creep.	**07**
Unit II: Cams and followers. Types of cams and followers, terminology, motions of follower: SHM, uniform velocity, uniform acceleration and retardation, Cycloidal displacement, velocity and acceleration diagrams.	**08**
Unit III: Friction Clutches, Brakes and Dynamometer Introduction, Types of clutch, uniform wear and Uniform pressure for the clutch, Types of brakes, effect of braking of a vehicle, dynamometers.	**08**
Unit IV: Gyroscope Introduction, Angular velocity, acceleration, Gyroscopic couple, Effect of gyroscopic couple on aeroplane, Naval ship, Stability of two wheels and four wheels vehicles.	**10**
Unit V: Balancing Static and dynamic balance, balancing of revolving several masses on several planes, Balancing of reciprocating masses in single and multi cylinder engines, balancing Machines.	**10**
Unit VI: Mechanical Vibrations Basic concepts and definitions; vibration measuring parameters- displacement, velocity, and acceleration, Single degree of freedom system, SHM, Undamped free vibrations, damped free vibrations, Types of damping. Forced Vibration: Effect of excitation, Excitation due to reciprocating and rotating unbalance, Vibration isolation and transmissibility	**9**

Note:

1. Unit No. II includes problems on drawing of CAM Follower on drawing sheets.

2. Unit No. V includes problems on balancing of masses to be solved on drawing sheets.

2. The course includes numerical treatment on the appropriate topics of above units

Text Books:

1. Bevan Thomas "The Theory of Machines" CBS Publishers and Distributors Ratan S. S. "Theory of Machines", Tata McGraw Hills
2. Dr. Bansal R. K. "Theory of Machines" Laxmi Publications Pvt. Ltd. New Delhi
3. Rao J.S. and Dukkipati R.V., "Mechanisms and Machine Theory" New Age International Pvt. Ltd.
4. "Theory of Machine" S.S.Rattan, Tata McGraw Hill, New Delhi
5. "Theory of Machine" R.S.Khurmi, S Chand Publications, New Delhi

Reference Books

1. Ulicker Jr. J.J., Penock G.R. and Shigley J.E. "Theory of Machines and Mechanisms" Tata McGraw Hills
2. Ghosh Amitabha and Mallik Asok Kumar, "Theory of Mechanisms and Machines" east- West Press Pvt. Ltd. New Delhi
3. Ramamurthy, "Mechanics of Machines" , Narosa Publishing House
4. Kimbrell J.T., "Kinematics Analysis and Synthesis" McGraw – Hill International Editons.

Class and Semester	:	**T. Y. B. Tech. (Mechanical Engineering) Part III, Semester V**
Course Title	:	**ENERGY ENGINEERING**

Teaching Scheme (Hours)	:	**Lectures 3 hours/weeks=3 x 13 weeks = 39 hours minimum** **Tutorial= -- hour/week** **Practical= -- hours/week**			*Total Credits*	: **03+00+00 =03**
Evaluation Scheme (Marks)	:	**CIE (20+20) + Course Work (10) = SEE = 50**	**IPE= Nil** **IOE=Nil** **EPE= Nil** **EOE = Nil**	: : :	**Grand Total=100**	*Duration of SEE* : **3 hours**
Revision:	:	**First**			*Month*	: **June 2018**

Pre-requisites **:** None

Type of Course **:** Theory

Course Domain **:** Core

Skills Imbibed **:** Cognitive: Recall, Understand, Apply, Analyze, Synthesize, Evaluate
Affective : Awareness, Respond, Value, Organize
Psychomotor: Imitation, manipulation, articulation, naturalization

Course Assessment Methods:

1. Continuous Internal Evaluation: Unit Test I and Unit Test II and Course work.
2. Semester End Examination (SEE)

Course Objectives:

1. To identify the present status of energy scenario.
2. To acquire the knowledge of renewable sources of energy and utilization.
3. To explaining the basic concept of solar radiation
4. To understand the new trends in energy sectors.

Course Outcomes:

At the end of this course, students will be able to

1. Identify renewable energy sources and their utilization.
2. Describe the components of a wind turbine and their functions
3. Explain the concepts and applications of fuel cell, bio gas plant, Tidal energy, etc.
4. Interpreting the solar radiation geometry and determine sun position and angles.
5. Analyze the present energy scenario.

Curriculum Content	**Hours**

Unit I:

a) Solar Energy **10**

Present status of energy scenario. Renewable and non-renewable energy sources. Availability, limitations, application of solar energy.

b) Solar Radiation

Structure of the sun, energy radiated by the sun, angular relationship of earth, and sun position, measurement of solar radiation. Derivations and Numerical Problems

Unit II: **14**

a) Flat Plate Collectors

Types and constructional details of flat plate collector, energy-balance for a flat plate collector, simple equation and performance curves, selection of flat plate collector.

b) Solar Concentrator

Limitations of flat plate collectors, various types of concentrators, their advantage, simple, thermal energy-balance equations, heliostats, selection of various materials for concentrators and reflecting surfaces.

Unit III:

a. Solar Heating Systems **07**

Solar water and space heating systems, passive solar heating systems, solar heating economics, solar air-heating systems, typical solar ponds.

b. Solar Distillation Systems

Various solar stills and selection, constructional details, solar energy storage systems

c. **Solar Electric Power**

Solar photovoltaic system, materials used and their performance, types of solar thermal power plant, working substance used, and temperature required various systems used.

Unit IV: Wind Energy

Availability of wind, various types of windmills and their constructional details and performance study, Power generated by windmills. Offshore Windmills. Derivations and Numerical Problems. **07**

Unit V:

a) **Geothermal Energy Sources** and application of geothermal energy, various types of geothermal power plants. **07**

b) Tidal Energy

Tidal energy available in India, suitable locations, study of various tidal energy power plants, and characteristics of turbines required.

Introduction to **Wave Energy,** Phenomenon of wave generation.

Unit VI:

a) **Bio gas** **07**

Chemistry of biogas generation variables affecting simple gas plants, types of digestoers their working and construction, application of biogas, use of bio-gas, case study of "pura" village bio gas electricity generation".

b) Fuel Cells

Introduction, Types and Applications.

(Note: The course includes numerical treatment on the appropriate modules of various units.)

Text Books

1. Sukhatme S.P., " Solar Energy", Tata McGraw Hill Publishing Company Limited, New Delhi, 1994
2. Rai G.D., " An Introduction to Power Plant Technology", Khanna Publishers, Third Edition, Delhi, 1996
3. Bansal N K and others " Non-Conventional Energy Sources".
4. S. Rao and Dr. B. B. Parulekar, Energy Technology, Khanna Publishers, New Delhi.

Reference Books

1. Krieth and Krieder, "Principles Of Solar Engineering", Tata McGraw Hill Publishing Company Limited, New Delhi, 1994
2. Wakil M.M., " Power Plant Technology", McGraw Hill International Book Company, 1984.
3. Pai B.K., and Ramprasad M.S., " Power generation through renewable sources of energy".
4. Garg H.P. and Prakash J., " Solar Fundamental and Application" Tata McGraw Hill Publishing Company Limited, New Delhi, 1997

Class and Semester	:	**T. Y. B. Tech. (Mechanical Engineering) Part III, Semester V**				
Course Title	:	**MANUFACTURING ENGINEERING – II**				
Teaching Scheme (Hours)	:	**Lectures 4 hours/weeks=4 x 13 weeks = 52 hours minimum Tutorial= -- hour/week Practical= 02 hours/week**		*Total Credits*	:	**04+00+01 =05**
Evaluation Scheme (Marks)	:	**CIE (20+20) + Course Work (10) = SEE = 50**	**IPE=Nil IOE=Nil EPE= Nil EOE = 50** : : :	**Grand Total=100**	*Duration of SEE*	: **4 hours**
Revision:	:	**First**			*Month*	: **June 2018**

Pre-requisites **:** In order to complete the course studies successfully, it is important to have a good command of English. Other Pre-requisites include study of Manufacturing Engineering – I, Applied Mechanics.

Type of Course **:** Theory

Course Domain **:** Core

Skills Imbibed **:** Cognitive: Recall, Understand, Apply, Analyze, Synthesize, Evaluate
Affective : Awareness, Respond, Value, Organize
Psychomotor: Imitation, manipulation, articulation, naturalization

Course Assessment Methods:

1. Continuous Internal Evaluation: Unit Test I and Unit Test II and Course work.
2. Semester End Examination (SEE)

Course Objectives:

1. To study of metal cutting technology including the process, measurements, design and selection of various cutting tools.
2. To introduce the design practices of jigs, fixtures and die design for presswork.
3. To introduce the students to various non conventional machining processes. .
4. To introduce advanced CNC based manufacturing.

Course Outcomes:

Student will able to

1. Understand the metal cutting action with single point cutting tool and demonstrate cutting tool geometry
2. Design jigs and fixtures for simple components
3. Design press tool die for simple components.
4. Justify the need of various non conventional machining processes

Curriculum Content	**Hours**

Unit I: Theory of Metal Cutting – I **09**

Introduction to metal cutting, wedge action, concept of speed, feed and depth of cut, orthogonal and oblique cutting. Mechanics of metal cutting-Chip formation, Types of chips, cutting ratio, Theories of shear angle, shear plane and shear angle, velocity relationships, force measurement by tool dynamometers, estimation of cutting forces, Merchants circle of forces, cutting tool materials and their properties, machinability of metals- factors affecting, improvement and machinability index

Unit II: Theory of Metal Cutting – II **08**

A. Tool life - Types of wear, relationship with cutting parameters, Taylor's equation and improvement measures. Surface finish- Factors affecting, effect of cutting parameters, improvements. Heat generation in machining, its effect on cutting force, tool life and surface finish, types and selection criteria of cutting fluids.

B. Tool geometry- Parts, angles and types of single point cutting tools, tool geometry of single point cutting tool, tool geometry of multipoint cutting tools.-drills, milling cutters, reamers.

Unit III: Design of Jigs and Fixtures **10**

Definition, Applications, basic elements, principles and types of locating, clamping and indexing elements, auxiliary elements like tenon, setting block etc. Type of Drilling jigs and Milling fixtures-Design consideration of Jigs and fixtures with respect to different operations.

Unit IV: Press Tools **11**

Elements of Dies and Punch set. Types of dies – simple, compound, combination and progressive dies and punches of various press working operations such as punching, blanking, drawing, bending, forming, coining etc. Design of Blanking die, Progressive die, Calculations of clearances, center of pressure, different forces, press tonnage, strip layout, sheet utilization ratio, methods of reducing forces.

Unit V: Non-Conventional Machining **07**

Introduction, Classification. Introduction, Principle, Working and Applications of - Electrochemical Machining, Abrasive Jet Machining, Ultrasonic Machining, Water Jet Machining, Electric Discharge Machining, Electron Beam Machining.

Unit VI: Introduction advanced manufacturing **07**

- CNC Technology and CNC tooling: Introduction, Construction and working of CNC, DNC and machining center., Automatic Tool Changer (ATC) and Automatic Tool Setter, Automatic pallet changer (APC).
- Rapid prototyping – concept, advantages, applications, study of 3D printing, file formats.

(Note: 1. The unit no. III includes drawing a jigs/ fixtures for simple objects where as unit no. IV includes drawing sheet on press tools.
2. The course includes numerical treatment on the appropriate modules of various units.)

Text Books

1. Chapman, 'Workshop technology vol. I,II and III, Edward Arnold Publication Ltd. London
2. Hajara Chaudhari S.K., 'Workshop Technology, Vol. I and II', Media Prom and Publication, Mumbai..
3. R. K. Jain, 'Production technology', Khanna Publications.
4. Hoffman: 'Introduction to Jigs and Fixtures', Galgotia Publishers.
5. S. K Hajra Choudhury, 'Elements of Workshop Technology Vol. II', , Media Promoters and Publishers, Mumbai.
6. P.C. Sharma, 'Text Book of Production Engineering', , S. Chand Publication, 11th Edition.
7. 'Machine Tool Engineering' G.R. Nagapal, Khanna Publication.
8. 'Principles of Modern Manufacturing', Groover, Wiley Publication., 5th Edition.
9. T. A. Grimm and Associates, Users Guide to Rapid Prototyping, Society of Manufacturing Engineers (SME) ISBN 0872636976

Reference Books

1. HMT Hand book- Production Technology
2. S. E. Rusinoff: 'Manufacturing Processes', Times India Press. Doyle, 'Manufacturing Processes and Materials for engineers, Prentice Hall of India Press.
3. S. K. Basu, 'Fundamentals of Tool Design', Oxford IBH
4. Mr. Arshinnov, 'Metal Cutting Theory and Tool design', MIR Publication
5. 'Fundamentals of Tool Design' ASTME, Prentice-Hall of India Private Ltd., New Delhi Publication, (1976).
6. Donaldson, 'Tool Design',THM Publication, 3rd Edition.
7. Sen and Bhattacharya, 'Theory of Metal Cutting', New Central Book Agency, (1965)
8. Kempster, 'Jigs and Fixtures', ,ELBS.
9. Rapid Prototyping theory and practice, Manufacturing System Engineering Series, Ali K.
10. Rapid Prototyping- case book, J. A. McDonalds, C. J. Ryall, Wiley Eastern

Class and Semester	:	**T. Y. B. Tech. (Mechanical Engineering) Part III, Semester V**					
Course Title	:	**HEAT AND MASS TRANSFER**					
Teaching Scheme (Hours)	:	**Lectures 3 hours/weeks=3 x 13 weeks = 39 hours minimum Tutorial= -- hour/week Practical= 02 hours/week**			*Total Credits*	:	**03+00+01 =04**
Evaluation Scheme (Marks)	:	**CIE (20+20) + Course work (10) = SEE = 50**	**IPE=Nil IOE=Nil EPE= 50 EOE = Nil**	:	**Grand Total=100**	*Duration of SEE*	: **3 hours**
Revision:	:	**First**				*Month*	: **June 2018**

Pre-requisites **:** In order to complete the course studies successfully, it is important to have a good command of English. Other Pre-requisites include Engineering Physics, Engineering Thermodynamics-I and Fluid Flow Operations.

Type of Course **:** Theory

Course Domain **:** Core

Skills Imbibed **:** Cognitive: Recall, Understand, Apply, Analyze, Synthesize, Evaluate
Affective : Awareness, Respond, Value, Organize
Psychomotor: Imitation, manipulation, articulation, naturalization

Course Assessment Methods:

1. Continuous Internal Evaluation: Unit Test I and Unit Test II and course work.
2. Semester End Examination (SEE)

Course Objectives:

1. To introduce the various mechanisms of heat and mass transfer that characterizes a given physical system.
2. To familiarize conservation equations along with models for heat transfer processes.
3. To prepare the analysis of one-dimensional steady and unsteady partial differential equations.
4. To develop representative models of real-life heat transfer processes and systems.

Course Outcomes:

At the end of course student will able to

5. Demonstrate the basic laws of heat and mass transfer and compute the transfer rate.
6. Analyse problem involving steady and transient state heat transfer.
7. Asses the heat exchanger performance by using the LMTD and NTU.

Curriculum Content	**Hours**
Unit-I: Introduction 1 Introduction Introduction to Heat transfer, Difference between thermodynamics and heat transfer, Modes of heat transfer. The laws of heat transfer, Thermal conductivity and coefficient of heat transfer.	**02**
Unit-II: Conduction Simple steady state problems in heat conduction, concept of thermal resistance and conductance. General equation of temperature field in three dimensional Cartesian co- ordinate systems. Application of above (one dimensional case) equation to the system of plane wall (including composite structure) as well as to the system with radial heat conduction i.e. Cylinders and Sphere (including composite structures). Steady state conduction one dimensional) through extended surface (fins) of constant cross section. One dimensional steady state heat conduction with uniform heat generation, (plane wall and solid cylinder) critical radius of insulation. Concept of unsteady state heat conduction. Transient heat flow system with negligible internal resistance.	**09**
Unit-III: Free and Forced Convection Mass, momentum and energy conservation equations, non-dimensional numbers, hydrodynamic and thermal boundary layers, basics of heat transfer in external and internal laminar and turbulent	**09**

flows, and use of co-relations. Free Convection and use of its co-relations.

Unit-IV: Boiling and Condensation

05

Nucleate and film boiling phenomenon: drop wise and film wise condensation, Nusselt's theory of condensation nature of heat transfer in such phenomenon. Introduction to Mass Transfer: Introduction, modes of mass transfer, analogy between heat and mass transfer, Mass diffusion, (Mass basis/Mole basis/Fick's law of diffusion).

Unit-V: Radiation

09

Nature of thermal radiation, definitions of absorptivity, reflectivity, transmissivity, monochromatic emissive power, total emissive power and emissivity. Concept of black body and gray body. Kirchhoff laws, Wien's law and Planck's law. Deduction of Stefan Boltzmann equation. Lambert's cosine rule, Intensity of radiation. Energy change by radiation between two black surfaces with non-absorbing medium in between and in absence of reradiating surfaces. Geometric shape factor. Energy exchange by radiation between two gray surfaces without absorbing medium and absence of radiation and radiosity. Radiation network method, network for two surfaces

Unit-VI: Heat Exchangers

05

Heat Exchangers, Classification according to flow arrangement, Tubular heat exchangers, Extended surface heat exchangers. Fouling factor, mean temperature difference, LMTD for parallel flow, counter flow, mean temperature for cross flow, correction factor, and special cases. The effectiveness by NTU method, effectiveness of parallel, counter flow

(Note: The course includes numerical treatment on the appropriate units.)

Text Books

1. J.P. Holman: Heat Transfer; McGraw Hill Book Company, New York.
2. Gupta and Prakash: Engineering Heat Transfer, New Chand and Bros., Roorkee (U.P.) India.
3. R.C. Sachdeva: Fundamentals of Engineering Heat and Mass Transfer, Wiley Eastern Ltd. India
4. P.K. Nag, "Heat Transfer", Tata McGraw Hill Publishing, 5th edition, 2008.
5. Yunus. A. Cengel, "Heat Transfer – A Practical Approach", Tata McGraw Hill, 3rd edition, 2006.

Reference Books

1. Incropera and Dewitt: Fundamentals of Heat and Mass Transfer, John Wiley and Sons, New York.
2. Frank Kreith: Principles of Heat Transfer, Harper and Row Publishers, New York.
3. Donald Q. Kern: Process Heat Transfer, Tata McGraw Hill Publishing Company Ltd., New Delhi.
4. Latif M. Jiji, *"Heat Conduction", Springer*, 3rd edition, 2009.
5. H. Schlichting , K. Gersten, *" Boundary Layer Theory"* Springer, 8th edition, 2000.
6. K Ramesh. Shah, Dusan P. Sekulic, "*Fundamentals of Heat Exchanger Design"* Wiley, 5th edition, 2012

Class and Semester	:	**T. Y. B. Tech. (Mechanical Engineering) Part III, Semester V**						
Course Title	:	**LABORATORY : THEORY OF MACHINES – II**						
Teaching Scheme (Hours)	:	**2 hr /week= 2 x13= 26 hours**				*Credits*	:	**1**
Evaluation Scheme (Marks)	:	**IPE** : **Nil** **EPE** : **Nil** **IOE** : **Nil** **EOE** : **50**				*Duration of Exam (in case of External Evaluation)*	:	**02 hours**
Revision:	:	**First**				*Month*	:	**June 2018**

Pre-requisites **:** None

Type of Course **:** Practical

Course Domain **:** Core

Skills Imbibed **:** Cognitive: Understand, Apply, Analyze, Evaluate, Create
Affective : Awareness, Respond, Value, Organize
Psychomotor: Perception, Imitation, manipulation, articulation

Course Assessment Methods:

Practical Journal Assessment, External Oral Examination

Course Objectives:

1. To Study the various types mechanical/transmission type dynamometer
2. To analyze physical principles and phenomenon of Vibrations.
3. To Study the Measure vibration parameters in single degree of freedom systems
4. To Analyze natural frequency of 1 dof (Degree of Freedom)

Course Outcomes:

At the end of course student will able to

1. Explain various types mechanical/transmission type dynamometer
2. Interpret physical principles and phenomenon of Vibrations.

3. Measure vibration parameters in single degree of freedom systems
4. Evaluate natural frequency of 1 DoF.

Experimental List :

The students should perform the following experiments. (Any Eight)

1. To determine the belt slip.
2. To study frictional properties of clutch/brake lining and to determine experimentally torque carrying capacity and slip of the clutch or brake.
3. To determine the coefficient of friction and wear of a given material.
4. Study of mechanical/transmission type dynamometer.
5. Verification of Gyroscopic principle and determination of gyroscopic couple
6. Study of principle of static and dynamic balancing machines.
7. Determination of natural frequency of transverse vibrations of a bar.
8. Determination of damping coefficient of torsional vibrations.
9. Determination of node point of two rotor system.
10. Determination of critical speed of shaft of single rotor.
11. To draw cam profile for various types of follower motion

Lab Manual : Laboratory Course Manual and equipment wise Standard Operating Procedure to follow.

Class and Semester	:	**T. Y. B. Tech. (Mechanical Engineering) Part III, Semester V**						
Course Title	:	**LABORATORY: COMPUTER AIDED DRAFTING (CAD)**						
Teaching Scheme (Hours)	:	**2 hr /week= 2 x13= 26 hours**				*Credits*	:	**1**
Evaluation Scheme (Marks)	:	**IPE** : **Nil** **EPE** : **50** **IOE** : **Nil** **EOE** : **Nil**				*Duration of Exam (in case of External Evaluation)*	:	**02 hours**
Revision:	:	**First**				*Month*	:	**June 2018**

Pre-requisites **:** Basic understanding of engineering graphics, machine drawing, understanding of various engineering components.

Type of Course **:** Practical

Course Domain **:** Core

Skills Imbibed **:** Cognitive: Understand, Apply, Analyze, Evaluate, Create
Affective : Awareness, Respond, Value, Organize
Psychomotor: Perception, Imitation, manipulation, articulation

Course Assessment Methods:

Practical Journal Assessment, External Practical Examination

Course Objectives:

1. To understand importance of CAD in field of engineering drawing.
2. To learn various commands in CAD software
3. To interpret production drawings.
4. To give hands on training on CAD package.

Course Outcomes:

At the end of course student will able to

1. Describe the significance of CAD in manufacturing.
2. Develop a 2D model of engineering components using various commands.
3. Develop a 3D model of engineering components using various commands.

4. Produce production drawings and interpret it.

Experimental List :

1 Basic command to draw 2- D objects like line, point, circle, arc, ellipse, polygon, polyline, spline etc.
2. Edit Commands: Erase, extension, break, fillet, chamfer, trim, scale, etc
3.Commands like line type, Dimension, text style etc
4. Viewing and other: Zoom, pan, mirror, rotate, move objects, arrange blocks, offset etc.
5. Hatching of sections.
6. Use of layers in drawing.
7. Plotting of drawing.
8. Introduction to 3- D modeling – sketcher, part design, assembly and drafting workbenches.
9. Modify commands, view port, UCS, etc.

LAB WORK

1. Computer aided drafting of four simple components and print out of the same.
2. One assignment on drawing of details and assembly containing 6 - 8 component with Tolerance, machining symbol etc. and plotting the same.
3. One assignment on 3-D drawing of one simple component and plotting its 2-D views along with 3 D object drawing.
4. Redraw given production drawing and to interpret it.

Note: Latest computer aided drafting software version like AutoCAD and any 3D modeling software are to be used.

Instructions for practical examination:

1. Every student shall be given one problem each.
2. Oral shall be based on the problem solved in software package and the journal.

Lab Manual **:**

- Institute's Laboratory Course Manual and equipment wise Standard Operating Procedure to follow.

Reference Books **:**

1. Ibrahim Zeid "CAD/CAM – Theory and Practice" Mc Hill, International edition, 1998
2. P. N. Rao "CAD/Cam principles and operations", Tata McGraw Hill
3. M. P. Groover and E. W. Zimmers Jr., "CAD/CAM" - Prentice Hall of India Pvt. Ltd.
4. New Delhi, 18th Edition, 1999.
5. User manuals of particular software package
6. AutoCAD Manual.

Class and Semester	:	**T. Y. B. Tech. (Mechanical Engineering) Part III, Semester V**					
Course Title	:	**WORKSHOP PRACTICE –III**					
Teaching Scheme (Hours)	:	**2 hr /week= 2 x13= 26 hours**			*Credits*	:	**1**
Evaluation Scheme (Marks)	:	**IPE : Nil EPE : 50** **IOE : Nil EOE : Nil**			*Duration of Exam (in case of External Evaluation)*	:	**02 hours**
Revision:	:	**First**			*Month*	:	**June 2018**

Pre-requisites	**:**	Manufacturing Engineering , Machine Drawing
Type of Course	**:**	Practical
Course Domain	**:**	Core
Skills Imbibed	**:**	Cognitive: Understand, Apply, Analyze, Evaluate, Create Affective : Awareness, Respond, Value, Organize Psychomotor: Perception, Imitation, manipulation, articulation

Course Assessment Methods:

Practical Journal Assessment and External Practical Examination

Course Objectives:

1. To discuss various Metal Removal Processes and Machine tools
2. To demonstrate the application of various cutting tools used in various manufacturing process
3. To Design the sequence of various processes required to manufacture the components

Course Outcomes:

At the end of course student will able to

1. Prepare job using plain turning, taper turning, external threading and knurling operation with its process sheet.
2. Demonstrate thread manufacturing processes and gear train calculations.
3. Select the suitable machining operations and prepare process sheet to manufacture component
4. Explain gear manufacturing processes and finishing processes used in the industry.

Experimental List :

1. One job of plain turning, taper fuming, external threading and knurling operation with its process sheet.
2. Description on thread manufacturing processes and gear train calculations.
3. Journal Consists of Following: -
    a. Process sheet and tool layout on Capstan /Turret lathe.
    b. Setting of milling machine for gear cutting.
    c. Study and demonstration of grinding machine (Surface, cylindrical and center less).
    d. Study and demonstration of shaper/planer (mechanisms and stroke).
4. Industrial visit to study gear manufacturing processes.

I. Assessment of journal based on above term work and industrial visit report is to be done by the teaching staff member assisted by workshop staff.

II. [Jobs carry 15 marks and journals carry remaining 10 marks and 25 marks for external practical exam job.]

III. The load of workshop practice III will be allotted to the teaching staff and will be assisted by workshop staff for completing the jobs.

Lab Manual **:**

- Laboratory Course Manual and equipment wise Standard Operating Procedure to follow.

TEXT BOOKS:

1. "A Textbook of Production Technology (Manufacturing Processes)", P.C. Sharma, S. Chand and Company Pvt.Ltd, New Delhi.
2. "Workshop Technology vol. II", B.S. Raghuvanshi, Dhanapat Rai Publications Pvt.Ltd, New Delhi.10th Edition.
3. "Workshop Technology vol. II", W. A. J. Chapman, Viva Books Pvt.Ltd,New Delhi.
4. "Elements of Workshop Technology vol. II", S.K.Hajra Choudhury and A.K. Hajra Choudhury , Media promoters and Publishers Pvt.Ltd,New Delhi.
5. "Production technology", R. K. Jain, Khanna Publishers, Delhi.

Reference Books

1. HMT Hand book- Production Technology
2. Campbell J.S. : Principles of manufacturing Materials and Processes, McGraw-Hill, New York.
3. ASTM Volumes on Welding, casting, forming and material selection
4. Manufacturing Processes And System 9E P. Ostwald, J. Munoz, John Wiley and Sons (asia) Pvt.Ltd

Class and Semester	:	**T. Y. B. Tech. (Mechanical Engineering) Part III, Semester V**							
Course Title	:	**INTERNSHIP I and MINI PROJECT**							
Teaching Scheme (Hours)	:	**2 hr /week= 2 x13= 26 hours**					*Credits*	:	**1**
Evaluation Scheme (Marks)	:	**IPE**	:	**Nil**	**EPE**	: **Nil**	*Duration of Exam (in case of External Evaluation)*	:	**02 hours**
		IOE	:	**50**	**EOE**	: **Nil**			
Revision:	:	**First**					*Month*	:	**June 2018**

Pre-requisites **:** Workshop practice I, II, Theory of Machine – I

Type of Course **:** Practical

Course Domain **:** Core

Skills Imbibed **:** Cognitive: Understand, Apply, Analyze, Evaluate, Create
Affective : Awareness, Respond, Value, Organize
Psychomotor: Perception, Imitation, manipulation, articulation

Course Assessment Methods:

Assessment of Internship report, Seminar / presentation, demonstration of model.

Course Objectives:

1. To understand the ―Product Development Process including budgeting through Mini Project.
2. To plan for various activities of the project and distribute the work amongst team of two members.
3. To develop student‘s abilities to transmit technical information clearly and test the same by delivery of seminar based on the Mini Project.
4. To understand the importance of document design by compiling Technical Report on the Mini Project work carried out

Course Outcomes:

At the end of course student will able to

1. Understand, plan and execute a Mini Project with the team.
2. Implement various manufacturing techniques, CAD learnt so far for designing and developing a prototype of a model.
3. Prepare a technical report based on the Mini project.
4. Deliver technical seminar based on the Mini Project work carried out.

I. The purpose of mini project is to promote self-study, innovative, creative thinking and independent research ability. Students have to initiate their own small conceptual or practical based projects individually as a team of no more than 2 members. While making this exercise it is expected that the knowledge acquired by them through application of subjects leant so far is applied by them carrying out mini project work will certainly help the students to for satisfactory and successful complete their major project in the final year.

II. Report of Internship I will be submitted by each student along with its internship certificate. Students, through the seminar, will present various points / sections / structure / processes observed during internship. The assessment will be done by mini project guide.

Project Completion and Assessment

A report is to be written upon completion of the activity. For team projects, each member has to write his own report. The report should include academic content such as the background, objectives, product/system description, the work done, the achievements and difficulties encountered. Students will deliver a seminar and will make the demonstration of their work.

Class and Semester	:	**T. Y. B. Tech. (Mechanical Engineering) Part III, Semester V**						
		LABORATORY						
Course Title	:	**HEAT AND MASS TRANSFER**						
Teaching Scheme (Hours)	:	**2 hr /week= 2 x13= 26 hours**				*Credits*	:	**1**
Evaluation Scheme (Marks)	:	**IPE** : **Nil** **EPE** : **50** **IOE** : **Nil** **EOE** : **Nil**				*Duration of Exam (in case of External Evaluation)*	:	**02 hours**
Revision:	:	**First**				*Month*	:	**June 2018**

Pre-requisites **:** Laboratory work in Engineering Physics, Chemistry-I and Fluid Flow Operations.

Type of Course **:** Practical

Course Domain **:** Core

Skills Imbibed **:** Cognitive: Understand, Apply, Analyze, Evaluate, Create
Affective : Awareness, Respond, Value, Organize
Psychomotor: Perception, Imitation, manipulation, articulation

Course Assessment Methods:

Practical Journal Assessment and External Practical Examination

Course Objectives:

1. To understand and execute experiments
2. To understand measuring equipments and apply
3. To Analyze the data from experiment and correlate to basic
4. To apply learning in evaluating heat exchanger performance

Course Outcomes:

At the end of course student will able to

1. Compare, select and analyze right mode of heat transfer.
2. Understand basics of subject by experience.
3. Interpret results.
4. Set process for experimentation

Experimental List **:**

Students have to perform following experiments**:**

1. Determination of thermal conductivity of insulating powder.
2. Determination of thermal conductivity of a given metal rod.
3. Determination of thermal conductivity of a given liquid.
4. Determination of thermal conductivity of composite slab.
5. Determination of heat Transfer Coefficient in Natural Convection from Cylinder.
6. Determination of heat Transfer Coefficient in Forced Convection from Cylinder.
7. Determination of Critical Heat Flux
8. Study of Performance of parallel and counter flow heat exchanger
9. Determination of emissivity of given surface
10. Determination of Stefan Boltzmann Constant.

Lab Manual **:**

- Laboratory Course Manual and equipment wise Standard Operating Procedure to follow.

Class and Semester	:	**T. Y. B. Tech. (Mechanical Engineering) Part III, Semester V**						
Course Title	:	**LABORATORY: MANUFACTURING ENGINEERING II**						
Teaching Scheme (Hours)	:	**2 hr /week= 2 x13= 26 hours**				*Credits*	:	**1**
Evaluation Scheme (Marks)	:	**IPE** : **Nil** **EPE** : **Nil** **IOE** : **Nil** **EOE** : **50**				*Duration of Exam (in case of External Evaluation)*	:	**02 hours**
Revision:	:	**First**				*Month*	:	**June 2018**

Pre-requisites **:** Laboratory work in workshop practice I and II

Type of Course **:** Practical

Course Domain **:** Core

Skills Imbibed **:** Cognitive: Understand, Apply, Analyze, Evaluate, Create
Affective : Awareness, Respond, Value, Organize
Psychomotor: Perception, Imitation, manipulation, articulation

Course Assessment Methods:

Practical Journal Assessment, External Oral Examination

Course Objectives:

1. To Study of cutting tools, their geometry and importance in cutting action
2. To design and drawing of jigs, fixtures and press tools for simple objects
3. To comparative study of various conventional and non conventional machining processes
4. To Understanding 3 D Printing

Course Outcomes:

At the end of course student will able to

1. Demonstrate understanding on single point cutting tool.
2. Design and draw a jig, fixtures and press tool.
3. Deliver a seminar on non conventional machining.

4. Deliver a seminar on 3 D printing

Experimental List **:**

1. Study of single point cutting tool.
2. Study of various elements of jigs and fixtures.
3. Design and drawing of any one drilling jig.
4. Design and drawing of any one milling fixture.
5. Design and drawing of any one die set.
6. Study of non conventional machining – presentation and report
7. Study of CNC machines
8. Study of rapid prototyping – 3D Printing – presentation and report

Lab Manual **:**

- Laboratory Course Manual and equipment wise Standard Operating Procedure to follow.

Class and Semester	:	**T. Y. B. Tech. (Mechanical Engineering), Part III, Semester V**							
Course Title	:	**RESEARCH METHODOLOGY**							
Teaching Scheme (Hours)	:	**2 hr /week= 2 x13= 26 hours**					*Credits*	:	**Nil**
Evaluation Scheme (Marks)	:	**Assignments**	:	**50**	**Written Test**	:	**25**	*Duration of Exam*	: **Not Applicable**
		Viva voce	:	**25**	**Grand Total**	:	**100**		
Revision	:	**Third**						*Month*	: **June 2018**

Pre-requisites	**:**	H.S.C level English Language Competency
Type of Course	**:**	Audit Course at institute level
Course Domain	**:**	Research Skills
Skills Imbibed	**:**	Cognitive: Understand, Predicting Situation, Comprehend, Affective : Receive, Listen, Respond, Showing self-reliance, Organize Psychomotor: Imitation, adaptation, articulation, origination

Course Assessment Methods:

The students will be given five assignments each for 10 marks. At the end of the course, there will be a written test of 25 marks and a viva voce of 25 marks. There will be assessment for a total of 100 marks. Based on the marks obtained, they will be awarded with a grade similar to other credit courses. Though it is an audit course, obtaining passing grade is essential.

Course Objectives:

1. To gain familiarity with research phenomenon or to achieve new insights into it (known as exploratory or formulative research studies) ;
2. To develop an understanding of various research designs and techniques;
3. To identify various sources of information for literature review and data collection;
4. To judge the frequency with which something occurs or with which it is associated with something else (known as diagnostic research studies);
5. To know about testing a hypothesis of a causal relationship between variables (known as hypothesis-testing research studies) ;

Course Outcomes: At the end of the course, the students

1. Will be able to understand some basic concepts of research and its methodologies;
2. Will be able to identify appropriate research topics ;
3. Will be able to select and define appropriate research problem and parameters;
4. Will be able to prepare a project proposal (to undertake a project) ;
5. Will be able to organize and conduct research (advanced project) in a more appropriate manner write a research report;

Curriculum Content	Hours
Unit I:Introduction to Research Definition and basic Types of research, Research process and steps in it, Concept of Hypothesis, Research proposals and aspects.	**03**
Unit II: Basic Statistics required for any research Introduction to Descriptive Statistics, Statistical data, Variable, Classification of data, exploratory data analysis, Measures of central tendency, Dispersion-Standard deviation, Correlation and regression analysis.	**06**
Unit III: Introduction to Design of Experiment: Concept of design of experiment, its objectives, strategies, Factorial experimental design, designing engineering experiments, basic principles, of replication. Guidelines of experiments.	**06**
Unit IV : Single Factor Experiment: Hypothesis testing, Analysis of Variance components (ANOVA) for fixed effect model; Total, treatment and error of squares, Degrees of freedom, Confidence interval; ANOVA for random effects model, Estimation of variance components, goodness of fit tests, Chi-Square test, Kolmogorov-Smirnov(K-S) test.	**07**
Unit V: Two factor Factorial Design: Basic definitions and principles, main effect and interaction, response surface and contour plots, General arrangement for a two factor factorial design; Models-Effects, means and regression, Hypothesis testing.	**07**

Reference Books **:**

1. Kothari, C.R., Research Methodology –Methods and techniques, New Age Publications, New Delhi, 2009.
2. Montgomery, Douglas C. (2007), 5/e, Design and Analysis of Experiments, Wiley India.
3. Montgomery, Douglas C. and Runger, George C. (2007), 3/e, Applied Statistics and Probability for Engineers, Wiley India.
4. J.Medhi, Statistics Methods, New Age Publications, New Delhi 2009.
5. Nabendu Pal and Saheb Sarkar, Statistics: Concepts and Applications, Prentice Hall of India Pvt.Ltd. New Delhi, 2004.
6. Panneerselvam, R., Research Methodology, Prentice-Hall of India, New Delhi, 2004.

Class and Semester	:	**T. Y. B. Tech. (Mechanical Engineering) Part III, Semester VI**					
Course Title	:	**MACHINE DESIGN – II**					
Teaching Scheme (Hours)	:	**Lectures 4 hours/weeks=4 x 13 weeks = 52 hours minimum** **Tutorial = --hour/week** **Practical= 02 hours/week**			*Total Credits*	:	**04+00+01 =05**
Evaluation Scheme (Marks)	:	**CIE (20+20) + Course work (10) SEE = 50**	**IPE=Nil** **IOE=50** **EPE= Nil** **EOE = 50**	: : :	**Grand Total=100**	*Duration of SEE*	: **3 hours**
Revision:	:	**First**				*Month*	: **June 2018**

Pre-requisites **:** In order to complete the course studies successfully, it is important to have a good command of English. Other Pre-requisites include Engineering Physics, strength of materials, Material science and machine design I etc.

Type of Course **:** Theory

Course Domain **:** Core

Skills Imbibed **:** Cognitive: Recall, Understand, Apply, Analyze, Synthesize, Evaluate
Affective : Awareness, Respond, Value, Organize
Psychomotor: Imitation, manipulation, articulation, naturalization

Course Assessment Methods:

1. Continuous Internal Evaluation: Unit Test I , Unit Test II.
2. Semester End Examination (SEE)

Course Objectives:

1. To study design against fluctuating load.
2. To study bearing selection procedure.
3. To study design procedure of spur gear, helical gear, bevel gear, worm and worm wheel.
4. To able to knowledge of tribological consideration of bearings design.

Course Outcomes:

1. Design of component for finite life and infinite life when subjected to fluctuating load.
2. Select bearings for a given applications from the manufacturers catalogue.
3. Design of elements like spur gears, helical gears, bevel gear, worm and worm wheel.
4. To study methods of lubrication and mounting of bearing.

Curriculum Content	Hours
Unit I: Design against fluctuating load Stress concentration, fatigue failure, endurance limit, notch sensitivity, Goodman and Soderberg diagrams, and modified Goodman diagram, fatigue design under combined stresses.	**9**
Unit II: Sliding contact bearing Modes of lubrication, hydrostatic step bearing, and Reynolds's equation, bearing design-selection of parameters, and construction details of bearings, Introduction of tribological considerations in design	**8**
Unit III: Rolling contact bearing Types, static and dynamic load carrying capacity, load-life relationship, selection of bearing from manufactures catalogue, comparison of sliding and rolling bearing, mounting of bearings.	**8**
Unit IV: Design of spur gears Design of spur gears, force analysis, gear tooth failures, number of teeth, face width, beam strength of gear tooth, effective load on gear tooth.	**9**
Unit V: Design of helical gears Virtual number of teeth, tooth proportions, force analysis, beam strength of helical gears, effective load on gear tooth, wear strength of helical gears, Design of bevel gears.	**9**
Unit VI: Design of worm gears Worm gear geometry and nomenclature, Force and efficiency analysis, Bending and surface fatigue strength, Worm gear thermal considerations, Methods of lubrications. **(Note: The course includes numerical treatment on the appropriate topics of various units.)**	**9**

Text Books

1. Bhandari V.B. – " Design of Machine Elements" – Tata McGraw Hill Publ. Co. Ltd.
2. Shigley J.E. and Mischke C.R. – "Mechanical Engineering Design" McGraw Hill Publ. Co. Ltd.
3. Hall, Holo Wenko and Laughlin, " Theory and problems of machine design, Tata McGraw Hill Publ. Co. Ltd.

Reference Books

1. Spotts M.F. and Shoup T.E. – " Design of Machine Elements" – Prentice Hall International.
2. Black P.H. and O. Eugene Adams – " Machine Design" – McGraw Hill Book Co.Ltd.
3. William C. Orthwein – " Machine Component Design" – West- publishing Co. and Jaico Publ. House.
4. "Design Data" – P.S.G. College of Technology, Coimbatore.
5. Juvinal R.C. – " Fundamentals of Machine Components Design" – John Wiley and Sons.
6. Hall A.S.; Holowenko A.R. and Laughlin H.G. – " Theory and Problems of Machine Design" Schaum's outline series

Class and Semester	:	**T. Y. B. Tech. (Mechanical Engineering) Part III, Semester VI**					
Course Title	:	**CONTROL ENGINEERING**					
Teaching Scheme (Hours)	:	**Lectures 4 hours/weeks=4 x 13 weeks = 52 hours minimum Tutorial= -- hour/week Practical= -- hours/week**			*Total Credits*	:	**04+00+00 =04**
Evaluation Scheme (Marks)	:	**CIE (20+20) + Course work (10) SEE = 50**	**IPE=Nil IOE=Nil EPE= Nil EOE = Nil**	: : :	**Grand Total=100**	*Duration of SEE*	: **3 hours**
Revision:	:	**First**				*Month*	: **June 2018**

Pre-requisites **:** In order to complete the course studies successfully, it is important to have a good command of English.

Type of Course **:** Theory

Course Domain **:** Core

Skills Imbibed **:** Cognitive: Recall, Understand, Apply, Analyze, Synthesize, Evaluate
Affective : Awareness, Respond, Value, Organize
Psychomotor: Imitation, manipulation, articulation, naturalization

Course Assessment Methods:

1. Continuous Internal Evaluation: Unit Test I and Unit Test II, Regular Tutorial, home assignments
2. Semester End Examination (SEE)

Course Objectives:

1. To Study the control system, its type and applications.
2. To prepare mathematical model of physical systems.
3. To Study concept of system stability and system response.
4. To Study various control actions.

Course Outcomes:

At the end of course student will able to

1. Understand control system, its type and applications.
2. Understand model of physical simple systems.
3. Determine system stability and system response.
4. Understand various control actions.

Curriculum Content	Hours
Unit I: Introduction to Automatic Control Generalized Control System Types, Open Loop and Closed Loop, Linear and Non-Linear, Time Variant and Time invariant Systems with examples. Advantages of Automatic Control Systems, Hydraulic/Pneumatic System, Hydraulic Servomotor, Jet – Pipe Amplifier, Pneumatic Amplifier. Thermal System, Gear Train	**10**
Unit II: Block Diagram Algebra and Mathematical Modeling Rules for Reduction of Block Diagram, Control System Components – Tachometer, D.C. Servomotor , Stepper Motor, Mathematical Model of Control System: Mechanical Translational Systems, Rotational System, Grounded Chair Representation, Electrical Elements, Analogous Systems, Force – Voltage Analog, Force – Current Analog, Mathematical Model of Liquid Level System	**14**
Unit III: Transient Response: General Form of Transfer Function, Concept of Poles and Zeros, Distinct, Repeated and Complex Zeros. Response of systems (First and Second Order) to Various Inputs (Impulse, Step, Ramp and Sinusoidal). Damping Ratio and Natural Frequency. Transient Response Specification	**07**
Unit IV: Stability and Root Locus Technique: Routh's Stability Criteria, Significance of Root Locus, Construction of Root Loci, General Procedure, Effect of Poles and Zeros on the System Stability.	**07**
Unit V: State Space Analysis: System Representation, Direct, Parallel, Series and General Programming, Conversion of State Space Model to Transfer Function.	**07**

Unit VI:

Frequency Response Analysis: Frequency Response Log Magnitude Plots and Phase angle Plots, Gain Margin, Phase Margin, Evaluation of Gain 'K', Polar Plots. System Compensation: Types of Compensators, Lead, Lag, Lead-Lag Compensators. **07**

(Note: The course numerical treatment on the appropriate topics of various units)

Text Books

1. Control System Engineering: R Anandnatarajan, P. Ramesh Babu, SciTech Publi.
2. Control Systems: A. Anand Kumar, Prentice Hall Publi.
3. Automatic Control Engineering: F.H. Raven (5th ed.), Tata McGraw Hill Publi.

Reference Books

1. Modern Control Systems: K Ogata, 3rd Ed, Prentice Hall Publi.
2. Automatic Control Systems: B.C. Kuo, 7th Ed, Willey India Ltd./ Prentice Hall Publi.
3. Automatic Control Engineering: D. Roy and Choudhari, Orient Longman Publi Calcutta
4. Modern Control Engineering K.Ogata Pearson Education

Class and Semester	:	**T. Y. B. Tech. (Mechanical Engineering) Part III, Semester VI**					
Course Title	:	**INTERNAL COMBUSTION ENGINES**					
Teaching Scheme (Hours)	:	**Lectures 4 hours/weeks=4 x 13 weeks = 52 hours minimum Tutorial= -- hour/week Practical= 02 hours/week**			*Total Credits*	:	**04+00+01 =05**
Evaluation Scheme (Marks)	:	**CIE (20+20) + Course work (10) SEE = 50**	**IPE=Nil IOE=Nil EPE= 50 EOE = Nil**	**Grand Total=100**	*Duration of SEE*	:	**03 hours**
Revision:	:	**First**			*Month*	:	**June 2018**

Pre-requisites **:** In order to complete the course studies successfully, it is important to have a good command of English. Other Pre-requisites include Engineering Physics, Chemistry-I, Thermodynamics-I etc.

Type of Course **:** Theory

Course Domain **:** Core

Skills Imbibed **:** Cognitive: Recall, Understand, Apply, Analyze, Synthesize, Evaluate
Affective : Awareness, Respond, Value, Organize
Psychomotor: Imitation, manipulation, articulation, naturalization

Course Assessment Methods:

1. Continuous Internal Evaluation: Unit Test I and Unit Test II, Course Work
2. Semester End Examination (SEE)

Course Objectives

1. To Understand basics of thermodynamic cycles of I. C. engines
2. To Study constructional details, nomenclature and classification of internal combustion engine
3. To Understand fuel properties, alternative fuels, combustion phenomenon in S. I. engine and C. I. engines
4. To Impart knowledge about various I. C. engines systems
5. To Impart knowledge of engine testing and performance analysis

Course Outcomes:

At the end of course student will able to

1. Analysis of Engine cycles and comparison between various engines.
2. Understand combustion process of SI and CI Engines.
3. Measure operating characteristics and Analyze engine performance parameters such as torque, brake power, mechanical efficiency, thermal efficiency and specific fuel consumption.
4. Demonstrate and compare engine systems
5. Demonstrate knowledge about the engine pollutants, its measurements, control system and emission norms

Curriculum Content	Hours

Unit No I.: Introduction and Thermodynamic Cycles

09

Basic components and terminology of IC engines, working of four stroke/two stroke - petrol/diesel engine, classification and application of IC engines, engine performance and emission parameters Assumptions, Otto, Diesel and Dual cycles, comparison of cycles, fuel air cycle and their significance, Valve Timing diagram, Actual engine cycle.

Unit No II. :S.I. Engines

09

Fuel Supply System, Carburetor, Types of carburetors, Electronic fuel injection system, GDI,
Qualities and Properties of fuels in S.I. Engine, Rating of fuels in S.I. Engine, Alternative Fuels
Combustion in spark Ignition engines, stages of combustion, flame propagation, rate of pressure rise, abnormal combustion, Phenomenon of Detonation in SI engines, effect of engine variables on Detonation. Combustion chambers.

Unit No III.: C.I. Engines

09

Fuel supply system, Injection Systems,
Qualities and Properties of fuels in C.I. Engine, Rating of fuels in C.I. Engine, Alternative Fuels
Combustion in Compression Ignition Engines, stages of combustion, factors affecting combustion, Phenomenon of knocking in CI engine. Comparison of knocking in SI and CI engines,
Types of combustion chambers, Concepts of Supercharging and Turbo charging.

Unit IV: Testing and Performance of I.C. Engine

09

Introduction to Indian Standards for testing of I.C. Engine, Basic Performance Parameters of I.C. Engine, Methods and Tests to determine power and efficiencies of I.C. Engine, characteristic curves,

heat balance sheet, Determination of IP, BP, FP, Mean effective pressure, Fuel consumption, Air Consumption, Engine efficiencies.

Unit V: Engine Emissions and Their Controls **08**

Air pollution due to IC engine, Engine emissions, Hydrocarbon emissions (HC) and Carbon monoxide emissions (CO), oxides of Nitrogen (NOx), Bharat stage norms. Emission control methods and systems for SI and CI engines, catalytic convertors. Concept of hybrid vehicles

Unit VI: Engine Systems **08**

Starting, Ignition, Governing, Lubrication, Cooling, Intake and Exhaust system.

(Note: The course includes numerical treatment on the appropriate topics of various units)

Text Books

1. V. Ganesan, "Internal Combustion Engines", Tata McGraw Hill, Second Edition.
2. Mathur and Sharma, "A Course in Internal Combustion Engines", R. P. Dhanapat Rai Pub. 1997
3. Heywood, "I.C. Engines Fundamentals", McGraw Hill

Reference Books

1. Edward E. Obert, "Internal Combustion Engines and Air Pollution", Internal Educational Pub, 1973
2. Kirpal Singh, "Automobile Engineering Vol. I and II", Standard Publishers
3. Crouse W.H.,"Automotive Mechanics", McGraw Hill
4. Willard W. Pulkrabek, "Engineering Fundamentals of the Internal Combustion Engine Platteville
5. John B. L. Heywood , "Internal Combustion Engine", McGraw-Hill.

Class and Semester	:	**T. Y. B. Tech. (Mechanical Engineering) Part III, Semester VI**					
Course Title	:	**METROLOGY AND QUALITY CONTROL**					
Teaching Scheme (Hours)	:	**Lectures 4 hours/weeks=4 x 13 weeks = 52 hours minimum** **Tutorial= -- hour/week** **Practical= 02 hours/week**			*Total Credits*	:	**03+00+01 =04**
Evaluation Scheme (Marks)	:	**CIE (20+20) + Course work (10) SEE = 50**	**IPE=Nil** **IOE=Nil** **EPE= Nil** **EOE = 50**	: : :	**Grand Total=100**	*Duration of SEE*	: **3 hours**
Revision:	:	**First**				*Month*	: **June 2018**

Pre-requisites **:** In order to complete the course studies successfully, it is important to have a good command of English.

Type of Course **:** Theory

Course Domain **:** Core

Skills Imbibed **:** Cognitive: Recall, Understand, Apply, Analyze, Synthesize, Evaluate
Affective : Awareness, Respond, Value, Organize
Psychomotor: Imitation, manipulation, articulation, naturalization

Course Assessment Methods:

1. Continuous Internal Evaluation: Unit Test I and Unit Test II, Regular Tutorial, home assignments
2. Semester End Examination (SEE)

Course Objectives:

1. To identify techniques to minimize errors in measurement.
2. To Study method and devices for measurement of length, angle and gear and thread parameters, surface roughness and geometric features of parts.
3. To Analyze and choose limits of plug and ring gauges

4. To Study methods of measurement in modern machineries
5. To Study quality control techniques and its application
6. To Study quality control charts and Statistical tools

Course Outcomes:

At the end of course student will able to

1. Identify techniques to minimize the errors in measurement
2. Identify methods and devices for measurement of length, angle, and gear and thread parameters, surface roughness and geometric features of parts.
3. Choose limits for plug and ring gauges.
4. Explain methods of measurement in modern machineries
5. Select quality control techniques and its applications
6. Plot quality control charts and suggest measures to improve the quality of product and reduce cost using Statistical tools

Curriculum Content	Hours
Unit I: a) **Measurements:** International standards of length-Line and end measurement, Need of measurement, possible errors in measurement, slip gauges. b) **Tolerances and gauging:** Unilateral and bilateral tolerances, Limits, Fits, Types of Fits, IS specifications of limits. Importances of limits, System in mass production, limit gauges used for plain and taper works.	**10**
Unit II a) **Magnification :** Principles and characteristics of measuring instruments, Mechanical, Optical, electrical, Pneumatic method of magnification, different types of Verniers, Micrometers, Dial gauges, Mechanical and pneumatic, Types of comparators. Use of comparators in inspection. b) **Measurement of angles, tapers and radius :** Bevel Protractor, Spirit level, Clinometers, angle Decker, standard balls and rollers for angle measurement, angle slip gauges, radius measurement of circular portion, measurement of concave and convex surface radius.	**10**
Unit III: a) **Interferometry:** Principle of Interferometry and application in checking of flatness, angle and height. b) **Straightness and Flatness:** Straight edge, use of level beam comparator, autocollimator	**08**

testing of flatness of surface plate (Theoretical treatment only) and surface roughness.

Unit IV

a) **Surface finish:** Types of textures obtained during machine operation, range of C.L.A. value in different operations in numerical assessment of surface finish (B.I.S. Specifications of C.L.A. value)-sample length of different machining operations. Direction of lay, texture, symbols, instruments used in surface finish assessment. **08**

b) **Quality control:** Concept of Quality and quality control, elements of quality and its growth, purpose, setup, policy and objective, factors controlling and quality of design and conformance, balance between cost and quality and value of quality. Specification of quality, planning through trial lots and for essential information.

Unit V

a) **Measurement of Spur Gears:** Run out checking, Pitch measurement, profile checking, backlash checking, tooth thickness measurement, alignment checking, errors in gears, checking of composite errors. **08**

b) **Measurement of External Threads:** Different errors in screw threads, measurement of forms of thread with profile projector, pitch measurement, measurement of thread diameter with standard wire, screw thread micrometer.

Unit VI

a) **Statistical Quality Control:** Importance of statistical method in quality control, measuring of statistical control variables and attributes. Measurement/inspection, different types of control charts(X Bars, R, P. charts) and their constructions and their application. **08**

b) **Acceptance Sampling:** Sampling inspection and percentage inspection, basic concept of sampling inspection, operating characteristic curves, conflicting interests of consumer and producer, producer and consumers risks, AWQL, LTPD, ADGL, single and double sampling plans.

(Note: This course includes numerical treatment on the appropriate topics of various units.)

Text Books

1. I. C. Gupta, “Engineering Metrology”, Dhanpat ana Rai Publications, New Delhi, India.
2. M. S. Mahajan, “Statistical Quality Control”, Dhanpat and Rai Publications.

Reference Books

1. R. K. Jain, "Engineering Metrology", Khanna Publications, 17th edition, 1975.
2. K. J. Hume, "Engineering Metrology", McDonald Publications, 1st edition, 1950.
3. A. W. Judge, "Engineering Precision Measurements", Chapman and Hall, London, 1957.
4. K. L. Narayana, "Engineering Metrology", Scitech Publications, 2nd edition.
5. J. F. Galyer, C. R. Shotbolt, "Metrology for Engineers", Little-hampton Book Services Ltd., 5th edition, 1969.
6. V. A. Kulkarni, A. K. Bewoor, "Metrology and Measurements", Tata McGraw Hill Co. Ltd., 1st edition, 2009.
7. Amitava Mitra, "Fundamental of Quality Control and Improvement", Wiley Publication.
8. V. A. Kulkarni, A. K. Bewoor, "Quality Control", Wiley India Publication, 01st August, 2009.
9. Richard S. Figliola, D. E. Beasley, "Theory and Design for Mechanical Measurements", Wiley India Publication.
10. E. L. Grant, "Statistical Quality Control", Tata McGraw Hill Publications.
11. J. M. Juran, "Quality Planning and Analysis", Tata McGraw Hill Publications.

Class and Semester	:	**T. Y. B. Tech. (Mechanical Engineering) Part III, Semester VI**					
Course Title	:	**INDUSTRIAL ENGINEERING AND MANAGEMENT**					
Teaching Scheme (Hours)	:	**Lectures 3 hours/weeks=3 x 13 weeks = 39 hours minimum Tutorial= 01 hour/week Practical= -- hours/week**			*Total Credits*	:	**03+01+00=04**
Evaluation Scheme (Marks)	:	**CIE (20+20) + Course Work (10) SEE = 50**	**IPE=Nil IOE=Nil EPE= Nil EOE = Nil**	**Grand Total=100**	*Duration of SEE*	:	**3 hours**
Revision:	:	**First**			*Month*	:	**June 2018**

Pre-requisites **:** In order to complete the course studies successfully, it is important to have a good command of English.

Type of Course **:** Theory

Course Domain **:** Core

Skills Imbibed **:** Cognitive: Recall, Understand, Apply, Analyze, Synthesize, Evaluate
Affective : Awareness, Respond, Value, Organize
Psychomotor: Imitation, manipulation, articulation, naturalization

Course Assessment Methods:

1. Continuous Internal Evaluation: Unit Test I and Unit Test II, Regular Tutorial, home assignments
2. Semester End Examination (SEE)

Course Objectives:

1. To acquaint students with the basic concepts of industrial engineering and management.
2. To impart fundamental knowledge of productivity and its improvement
3. To impart understanding of work study
4. To impart understanding for applying various techniques involved in industrial engineering

Course Outcomes:

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

1. Apply the basic concept and importance of industrial engineering.
2. Devise various ways of productivity improvement in given domain.
3. Solve case studies on plant location and plant layout
4. Perform method study and work measurement.

Curriculum Content

Unit I **09**

- Definition, Scope, Responsibilities, Important contributors to I.E., Tools and techniques of I.E.
- Introduction to Productivity and Work Study: Definition and scope, Productivity and quality of life, Evolution of work study, contribution of Taylor and Gilbreth, Work study techniques and basic procedure, Human factor in application of work-study.
- Method study:
  a) Definition, objectives and basic procedure.
  b) Record, Examine, Develop – Process chart symbols, Outline and flow process charts, Flow diagrams, Critically Examine Techniques.
  c) Movement of workers and material – string diagram, flow process charts worker Material and equipment type, multiple activity chart – Man – Machine, Machine- Machine chart, Travel charts for workplace.
  d) Methods and Movements at workplace- Principles of motion economy, Classification of movements, Two handed process chart, SIMO chart, Micro Motion study, Therbligs.
  e) Evaluate, Define, Install and Maintain methods

Unit II **05**

- Productivity: Concept, objectives, Factors affecting productivity, Tools and techniques to improve productivity,
- Productivity measurement. – Models.
- Value Engineering: Concept, steps, Applications.

Unit III **08**

- Work Measurement:
  Definition, objectives, basic procedure, Techniques of work measurement, Time study – Equipment and forms, selection of a job, steps in time study, breaking the job into elements, timing the elements; Rating in time study – standard rating and standard performance, factors affecting rate of working, standard time determination, use of time standards, allowances;

- Work sampling:
  Need, procedure for work sampling, determining time standard by work sampling.
- Predetermined time standards (PTS)-definition, methods time measurement (MTM) standard data from PTS, applications of PTS.
- MOST (Maynard Operation Sequence Technique) – Introduction, Methodology.

Unit IV **06**

- Production Planning and Control: Elements of PPC, PPC activity cycle. Planning – Pre-requisites of process planning, Steps in process planning, Factors affecting process planning, Process selection, Machine selection,
- Working conditions and Environment: Occupational hazards, health and safety, housekeeping, lighting, noise and vibrations, climatic conditions, ILO norms
- Ergonomics: Human factor engineering, man- machine interaction, Design of controls, environment factors, Anthropometry, workplace design.

Unit V **06**

- Site selection and plant layout: Factors affecting site selection, factors affecting layout design, types of layout, systematic layout planning procedure, travel chart, information gathering, flow analysis and activity analysis relationship diagram, space requirement and availability, designing of layout – use of CAD.
- Basics of material handling systems: Principles, functions and equipments, selection of MH systems, unit load concept in MH, Economics of material handling.

Unit VI **05**

- Job Evaluation and Merit Rating- Methods,
- Incentive schemes - Time, Piece, incentive systems, Halsey, Rowan, and Taylor's differential piece rate plan.

(Note: The course includes numerical treatment on the appropriate topics of various units.)

Text Books ***Text Books***

1. Edited by George Kanavaty, Introduction to Work Study-ILO, , Fourth Revised Edition, 1992

Reference Books ***Reference Books***

1. Work Study: - Curie and Faraday (ELBS)
2. Work Study by O.P. Khanna (DhanapatRai and Sons)
3. Maynard. H.B – Industrial Engineering Hand Book, McGraw Hill Book Company, New York
4. J. Adam EE , RJ Ebert Production and operation management- Prentice Hall Englewood Cliff,
5. N. Riggs. J L - Production system, planning, analysis and control – John Weily and sons, New York
6. David Sumanth, Productivity Engineering and Management- Tata McGraw Hill, New Delhi.
7. Bernes, R.L Motion and Time Study, Design and measurement of Work, John Weily India
8. Facility Layout and Location – An Analytical Approach, Francis et. al.(PHI)
9. Facilities Planning – 3/e, Tompkins, White, Bozer, Tanchoco (John Wiley & Sons)
10. Job Evaluation – ILO
11. Payment by Results, - ILO
12. Introduction to Work Study- International Labour Office Geneva
13. L.C.Jhamb- Work study and Ergonomics.
14. Miles Lawrence- Techniques of value Analysis and engineering- McGraw Hill Book Company, New York.
15. Samuel Eilon – Production planning and control.
16. James Dilworth, Production and operation management- McGraw Hill Book Company, New York.
17. Industrial Engineering and Management by Arun Vishwanath SCITECH publication.
18. Basu S.K., Sahu K.C and Rajiv B, Industrial Organization and Management –. PHI New Delhi, 2012
19. M.S. Sanders and E.J. McCormick, "Human Factors in Engineering Design", VI Edition, McGraw Hill
20. S. Dalela and Sourabh, "Work Study and Ergonomics". Standard Publishers, Latest Edition.

Class and Semester	:	**T. Y. B. Tech. (Mechanical Engineering) Part III, Semester VI**						
Course Title	:	**LABORATORY: METROLOGY AND QUALITY CONTROL**						
Teaching Scheme (Hours)	:	**2 hr /week= 2 x13= 26 hours**				*Credits*	:	**1**
Evaluation Scheme (Marks)	:	**IPE** : **Nil** **EPE** : **Nil** **IOE** : **Nil** **EOE** : **50**				*Duration of Exam (in case of External Evaluation)*	:	**02 hours**
Revision:	:	**First**				*Month*	:	**June 2018**

Pre-requisites **:** None

Type of Course **:** Practical

Course Domain **:** Core

Skills Imbibed **:** Cognitive: Understand, Apply, Analyze, Evaluate, Create
Affective : Awareness, Respond, Value, Organize
Psychomotor: Perception, Imitation, manipulation, articulation

Course Assessment Methods:

Practical Journal Assessment, External Oral Examination

Course Objectives:

1. Study the measurement using linear, angular circular features, dimensional and geometric features
2. Analyze the surface roughness of component
3. Study calibration of metrological equipment

Course Outcomes:

At the end of course, student will able to

1. Measure linear, angular circular features, dimensional and geometric features
2. Measure surface roughness of components
3. Calibration of metrological equipment

Experimental List **: Any Six Experiments**

1. Study and use of linear measuring Instruments
2. Study and Use of comparators
3. Study and Use of Angle Measuring instruments
4. Screw Thread measurement
5. Gear measurements and inspection.
6. Use of Optical profile projector
7. Study and Use of Control charts
8. Operating characteristics curves

Lab Manual **:**

- Laboratory Course Manual and equipment wise Standard Operating Procedure to follow.

Class and Semester	:	**T. Y. B. Tech. (Mechanical Engineering) Part III, Semester VI**						
		LABORATORY:						
Course Title	:	**INTERNAL COMBUSTION ENGINES**						
Teaching Scheme (Hours)	:	**2 hr /week= 2 x13= 26 hours**				*Credits*	:	**1**
Evaluation Scheme (Marks)	:	**IPE** : **Nil** **EPE** : **50** **IOE** : **Nil** **EOE** : **Nil**				*Duration of Exam (in case of External Evaluation)*	:	**02 hours**
Revision:	:	**First**				*Month*	:	**June 2018**

Pre-requisites **:** Laboratory work in Chemistry and Thermal Engineering

Type of Course **:** Practical

Course Domain **:** Core

Skills Imbibed **:** Cognitive: Understand, Apply, Analyze, Evaluate, Create
Affective : Awareness, Respond, Value, Organize
Psychomotor: Perception, Imitation, manipulation, articulation

Course Assessment Methods:

Practical Journal Assessment, Internal Practical Examination and External Practical Examination

Course Objectives:

1. To describe the testing and performance characteristics of I.C. Engine
2. To Explain the parts and complete knowledge of types of fuels used in I.C. Engine and the fuel supply systems.
3. To describe combustion process phenomenon in I.C. Engine
4. To understand different tests and methods for performance analysis of I.C. Engine
5. To explain the effects of emission and controlling techniques for I.C. Engine

Course Outcomes:

At the end of this course

1. Understand the complete operation of I.C. Engine
2. Find the performance of I.C. Engine and variation of various performance parameters with load and speed.

3. Analyze the performance of the variable compression ratio engine with computerized set up
4. Analyze various Engine Systems and components.
5. Understand the emission formation of I.C. Engines, its effects and norms

Experimental List **: Any seven**

Test Group: (any five)

1. Trial on four stroke Diesel Engine.
2. Trial on four stroke Petrol Engine.
3. Morse Test on multi cylinder Engine
4. Study and demonstration of various engine systems
5. Trial on computer controlled I.C. Engine
6. Measurement of exhaust emissions of SI / CI engines.
7. Test on variable compression ratio engine
8. Study of Alternative fuels
9. Visit to Engine or Engine Component Manufacturer or Engine Repairing Unit
10. Visit to Vehicle Testing Facility

Lab Manual **:**

- Laboratory Course Manual and equipment wise Standard Operating Procedure to follow.

Class and Semester	:	**T. Y. B. Tech. (Mechanical Engineering) Part III, Semester VI**						
Course Title	:	**LABORATORY: COMPUTER AIDED MANUFACTURING (CAM)**						
Teaching Scheme (Hours)	:	**2 hr /week= 2 x13= 26 hours**				*Credits*	:	**1**
Evaluation Scheme (Marks)	:	**IPE** : **Nil** **EPE** : **Nil** **IOE** : **50** **EOE** : **Nil**				*Duration of Exam (in case of External Evaluation)*	:	**02 hours**
Revision:	:	**First**				*Month*	:	**June 2018**

Pre-requisites **:** Laboratory work Engineering graphics, Machine drawing, Manufacturing Engineering I and II.

Type of Course **:** Practical

Course Domain **:** Core

Skills Imbibed **:** Cognitive: Understand, Apply, Analyze, Evaluate, Create
Affective : Awareness, Respond, Value, Organize
Psychomotor: Perception, Imitation, manipulation, articulation

Course Assessment Methods:

Practical Journal Assessment, Internal Practical Examination and External Practical Examination

Course Objectives:

1. To educate students by covering different aspects of computer Aided Manufacturing.
2. To inform students about latest software packages used in CAM.
3. To study automation in manufacturing.
4. To study various manufacturing systems.

Course Outcomes:

At the end of this course, student will able to

1. Demonstrate fundamental knowledge of CAM.
2. Identify the tool path for parts.

3. Write the CNC part program.
4. Apply the knowledge advanced manufacturing system.

Experimental List **:**

1. Study of advanced machine tools.
2. Study of numerical control programming for machines tools.
3. Study of various software packages.
4. Study of automation systems in manufacturing.
5. Study of FMS
6. Study of agile manufacturing
7. Study of lean manufacturing systems
8. Industrial visit.

Lab Manual **:**

- Laboratory Course Manual and equipment wise Standard Operating Procedure to follow.

Text Books **:**

1. CAD/CAM, Principles and Applications –P N Rao, McGraw Hill, 2010
2. CAD/CAM, Introduction, -Ibrahim Zeid, Tata McGraw Hill, 2007

Reference Books **:**

1. Computer Aided Manufacturing by Tien Chien Chang, Pearson Education Automation, Production Systems and Computer Integrated Manufacturing by Mikell Groover, Pearson Education.
2. Flexible Manufacturing Cells and System -William. W. Luggen Hall, England Cliffs, Newjersy.
3. P. Radhakrishnan, " Computer Numerical Control ", New Central Book Agency, 1992
4. Computer integrated manufacturing -S. Kant Vajpayee – Prentice Hall of India.
5. CAD/CAM, Principles and Applications –P N Rao, McGraw Hill, 2010
6. CAD/CAM, Introduction, -Ibrahim Zeid, Tata McGraw Hill, 2007

Class and Semester	:	**T. Y. B. Tech. (Mechanical Engineering) Part III, Semester VI**						
Course Title	:	**LABORATORY: MACHINE DESIGN – II**						
Teaching Scheme (Hours)	:	**2 hr /week= 2 x13= 26 hours**				*Credits*	:	**1**
Evaluation Scheme (Marks)	:	**IPE** : **Nil** **EPE** : **Nil** **IOE** : **50** **EOE** : **50**				*Duration of Exam (in case of External Evaluation)*	:	**02 hours**
Revision:	:	**First**				*Month*	:	**June 2018**

Pre-requisites **:** Laboratory work in Theory of machines, material science, strength of materials lab.

Type of Course **:** Practical

Course Domain **:** Core

Skills Imbibed **:** Cognitive: Understand, Apply, Analyze, Evaluate, Create
Affective : Awareness, Respond, Value, Organize
Psychomotor: Perception, Imitation, manipulation, articulation

Course Assessment Methods:

Assessment of assignments, Internal Oral Examination and External Oral Examination.

Course Objectives:

1. To study design of industrial mechanical systems consists of different types of gears.
2. To make conversant with preparation of working drawings
3. Ability to solve different problems based on design of gears.
4. Ability to solve different problems based on selection of bearing and fluctuating loads.

Course Outcomes:

1. To prepare detailed design report on industrial mechanical systems consists of different types of gears.
2. To prepare working drawings of industrial mechanical system.

3. To solve problems on different types of gears.
4. To solve problems on selection of bearing and fluctuating loads.

Experimental List **:** A term work shall consist of report on the following.

A) Total two design project

A detail design report and A 2 Size sheet containing working drawing of details and assembly of project based on any relevant mechanical system consisting of

i) Spur gear/ Helical gear.

ii) Bevel gear / Worm and worm wheel.

B) Assignments based on

i) Four problems on fluctuating loads.

ii) Study of Ball bearing mountings and its selection preloading of bearings.

iii) Four problems on design of gear drives including all types gears.

iv) Four problems on selection of bearing.

Class and Semester	:	**T. Y. B. Tech. (Mechanical Engineering) Part III, Semester VI**						
Course Title	:	**SEMINAR**						
Teaching Scheme (Hours)	:	**2 hr /week= 2 x13= 26 hours**				*Credits*	:	**1**
Evaluation Scheme (Marks)	:	**IPE** : **Nil** **EPE** : **Nil** **IOE** : **50** **EOE** : **Nil**				*Duration of Exam (in case of External Evaluation)*	:	**02 hours**
Revision:	:	**First**				*Month*	:	**June 2018**

Pre-requisites **:** Laboratory work in Theory of machines, material science, strength of materials lab.

Type of Course **:** Practical

Course Domain **:** Core

Skills Imbibed **:** Cognitive: Understand, Apply, Analyze, Evaluate, Create
Affective : Awareness, Respond, Value, Organize
Psychomotor: Perception, Imitation, manipulation, articulation

Course Assessment Methods:

Assessment of assignments, Internal Oral Examination.

Course Objectives:

1. To study design of industrial mechanical systems consists of different types of gears.
2. To make conversant with preparation of working drawings
3. Ability to solve different problems based on design of gears.
4. Ability to solve different problems based on selection of bearing and fluctuating loads.

Course Outcomes:

1. To prepare detailed design report on industrial mechanical systems consists of different types of gears.
2. To prepare working drawings of industrial mechanical system.
3. To solve problems on different types of gears.
4. To solve problems on selection of bearing and fluctuating loads.

Any topic of mechanical engineering application may be a seminar topic. The seminar may be based on proposed project work also. Seminar Load:- Maximum 9-10 students in one batch, Maximum 9-10students shall work under one Faculty Member Group of one student is not allowed under any circumstances. The faculty members can give a topics from their research domains. Interested students can approach and get allotted to faculty member.

For standardization of the seminar reports the following format should be strictly followed.

1 Page size : Trimmed A4
2. Top Margin : 1.00 Inches
3. Bottom Margin : 1.32 Inches
4. Left Margin : 1.5 Inches
5. Right Margin : 1.0 Inches
6. Para Text : Font - Times New Roman; 12 point
7. Line Spacing : 1.5 Lines
8. Page Numbers: Right aligned and in footer.
9. Headings : Font Times New Roman; 12 point New Times Roman, 14 point, Boldface
10. Certificate: All students should attach standard format of the entire seminar should be documented as one chapter.
11. References should have the following format

For Books: 1. “Title of Book”; Authors; Publisher; Edition;
For Papers: 2. “Title of Paper”; Authors; Conference Details; Year.

Marks:

1 Seminar Report: 25
2 Presentation: 25

All students have to present their seminars individually in front of the faculties.

Class and Semester	:	**T. Y. B. Tech. (Mechanical Engineering), Part III, Semester VI**							
Course Title	:	**INTRODUCTION TO FOREIGN LANGUAGE**							
Teaching Scheme (Hours)	:	**2 hr /week= 2 x13= 26 hours**					*Credits*	:	**Nil**
Evaluation Scheme (Marks)	:	**Assignments**	:	**50**	**Written Test**	:	**25**	*Duration of Exam*	: **Not Applicable**
		Viva voce	:	**25**	**Grand Total**	:	**100**		
Revision	:	**Third**						*Month*	: **June 2018**

Pre-requisites	**:**	As it is the introduction to the language, it has no any pre-requisites
Type of Course	**:**	Audit Course at institute level
Course Domain	**:**	Linguistics
Skills Imbibed	**:**	Cognitive: Understand, Predicting Situation, Comprehend, Affective : Receive, Listen, Respond, Showing self-reliance, Organize Psychomotor: Imitation, adaptation, articulation, origination

Course Assessment Methods:

The students will be given five assignments each for 10 marks. At the end of the course, there will be a written test of 25 marks and a viva voce of 25 marks. There will be assessment for a total of 100 marks. Based on the marks obtained, they will be awarded with a grade similar to other credit courses. Though it is an audit course, obtaining passing grade is essential.

Course Objectives:

1. To make the students able to communicate and translate in foreign languages for the *technical and scientific documentation*, beneficial to Defense and other Government sector services.
2. To make them globally competent in the era of industrial liberalization.
3. To complement their core studies in international business.
4. To make them confident while opting for better career prospects in Multinational Companies (MNCs) for technical and scientific translation/ interpretation tasks while working for joint ventures or collaborative partnership.

Course Outcomes:

1. The students will be able to acquire a good knowledge the basic grammar of foreign language and learn Alphabet, Common Words and Phrases in foreign language.
2. The students will also be able to learn to read the simple texts in foreign language.
3. The students would be able to speak a little using the greetings, well wishes etc. in Foreign Language.
4. The students will learn to count numbers, answer to the questions like, what is your name,

surname, tell age, and can initiate little communication in Foreign Language.

5. The students can also translate simple sentences in foreign language.

Curriculum Content	Hours
Unit I: General Information on Basic Grammar of the foreign language, Introduction to Alphabet.	**05**
Unit II: Gender of Noun, Number of Noun, Pronouns, Adjectives, Verbs and their usage in simple sentences, Numbers (up to 10), Simple Greetings in foreign language.	**05**
Unit III: General Questions in foreign language, like What is your name/surname?Who/What is this? Etc.	**04**
Unit IV: Simple narration about self/family/friend/University in foreign language chosen for studies. Practicing the learnt topics in the class itself.	**05**
Unit V: Formation of simple sentences using Parts of Speech, Information on Cases, One or Two simple lessons from any book.	**05**
Unit VI: Basic information on Country and Culture of language under study.	**04**

Reference Books **:**

1. V.N.Wagner and V. G.Ovsienko, Russian, People's Publishing House, New Delhi.
2. S. Khavronina and A. Shirochenskaya, Russian in Exercises.
3. Genki – Japan Times
4. Aural Comprehension in Japanese – Osamu and Nobuko Mizutani.
5. An Introduction to Modern Japanese - Osamu and Nobuko Mizutani.
6. Japanese for Today – Y. Yoshida.
7. Lagune 1(Full set), Published by Langers, (An imprint of Saraswati House Pvt.Ltd), New Delhi 1 10002 (India).

Equivalence of Pre Revised and Revised Structure
Third Year B. Tech. (Mechanical Engineering) Semester V and VI

The above detailed syllabus is a revised version of the Third Year B. Tech (Mechanical Engineering) Program being conducted by the Shivaji University at the Technology Department of the University. This syllabus is to be implemented from June 2018, (Academic year 2018-19). The prime feature of this revision is the transformation of the existing curriculum into the Outcome based curriculum as specified in NBA rules and regulations.

The Equivalence for the subjects/courses of Mechanical Engineering at Third Year B. Tech. Semester V and VI pre-revised and Revised Program under the faculty of Engineering and Technology is as follows.

Third Year B. Tech. Semester V (Mechanical Engineering)

Sr. No	Third Year B. Tech. (Mechanical Engineering) Semester VI Pre-revised syllabus	Third Year B. Tech. (Mechanical Engineering) Semester VI Revised syllabus	Remark
1.	Credits = 25	Credits = 25	No change in credits
2.	Machine Design – I	Machine Design – I	Slight modification in the content
3.	Theory of Machine – II	Theory of Machine – II	Slight modification in the content
4.	Energy Engineering	Energy Engineering	Slight modification in the content
5.	Manufacturing Engineering – II	Manufacturing Engineering. – II	Slight modification in the content
6.	Heat and Mass Transfer	Heat and Mass Transfer	Slight modification in the content
7.	**Laboratory** Theory of Machine – II	**Laboratory** Theory of Machine – II	Slight modification in the content
8.	**Laboratory** Manufacturing Engineering - II	**Laboratory** Manufacturing Engineering - II	Slight modification in the content
9.	**Laboratory** Heat and Mass Transfer	**Laboratory** Heat and Mass Transfer	Slight modification in the content
10.	**Laboratory** CAD - I	**Laboratory** CAD - I	Slight modification in the content
11.	**Laboratory** Workshop Practice– III	**Laboratory** Workshop Practice– III	Slight modification in the content

12.	**Laboratory** Mini project and Seminar	**Laboratory** Internship – I *(Mini Project)	Internship I with Mini project is introduced.
13.	Research Methodology (Audit Course)	Research Methodology (Audit Course)	No change
For above Theory Courses 2 to 6 the Continuous Internal Evaluation pattern is changed as bellow.			
	CIE = 50 (UT I = 25, UT II = 25)	CIE = 50 (UT I = 20, UT II = 20, Course work* =10)	Revised CIE marks distribution.

Audit course have not been assigned any credits. The students will be evaluated for these courses by the concerned course in charge. There will be grade conferred to the student. Obtaining passing grade is essential. Please refer to chart in the detail examination scheme. The chart shows the marks range and the respective grade.

* **Course work:** It consists of assignments, quiz, seminars, presentations, research papers and research articles, developing working models, surveys and activities related to course as designed by the course coordinator to suit the needs of the course and to complement programme outcomes. The practical work and its journal is not part of course work.

Third Year B. Tech. Semester VI (Mechanical Engineering)

Sr. No	**Third Year B. Tech. (Mechanical Engineering) Semester VI Pre-revised syllabus**	**Third Year B. Tech. (Mechanical Engineering) Semester VI Revised syllabus**	**Remark**
1.	Credits = 25	Credits = 25	No change in credits
2.	Machine Design – II	Machine Design – II	Slight modification in the content
3.	Control Engineering	Control Engineering	Slight modification in the content
4.	Internal Combustion Engines	Internal Combustion Engines	Slight modification in the content
5.	Metrology and Quality Control	Metrology and Quality Control	Slight modification in the content
6.	Industrial Engineering and Management	Industrial Engineering and Management	Slight modification in the content
7.	**Laboratory** Metrology and Quality Control	**Laboratory** Metrology and Quality Control	Slight modification in the content

8.	**Laboratory** Internal Combustion Engines	**Laboratory** Internal Combustion Engines	No Change
9.	**Laboratory** CAM	**Laboratory** CAM	Slight modification in the content
10.	**Laboratory** Machine Design - II	Laboratory Machine Design – II	Slight modification in the content
11.	Report and presentation of Industrial Tour	Seminar	Slight modification in the content
12.	Introduction to Foreign Language (Audit Course)	Introduction to Foreign Language (Audit Course)	No change
For above Theory Courses 2 to 6 the Continuous Internal Evaluation pattern is changed as bellow.			
	CIE = 50 (UT I = 25, UT II = 25)	CIE = 50 (UT I = 20, UT II = 20, Course work* =10)	Revised CIE marks distribution.

Audit course have not been assigned any credits. The students will be evaluated for these courses by the concerned course in charge. There will be grade conferred to the student. The grade will be based on conversion of marks obtained out of 50. (Obtaining passing grade is essential). Please refer to chart in the detail examination scheme. The chart shows the marks range and the respective grade.

* **Course work:** It consists of assignments, quiz, seminars, presentations, research papers and research articles, developing working models, surveys and activities related to course as designed by the course coordinator to suit the needs of the course and to complement programme outcomes. The practical work and its journal is not part of course work.