MOM II MEETING UDAC ONLINE HELD ON 02122020.pdf

SCHEME PIE 2019-20.pdf

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Approved
Dean, FA & UD

Department of Mechanical Engineering

Scheme & Syllabus

of

Bachelor of Technology

Production & Industrial Engineering

From III to VIII Semester

Effective from Academic session 18-19

for B.Tech.- P& IE (Effective for student admitted in first year in 19-20)

Mechanical deptt. 20-21 III sem onwards

University Teaching Departments

Rajasthan Technical University, Kota

Minutes of Meeting
II Meeting (online) of Academic Council, University Departments, RTU, Kota
27 November, 2020, 3:30 pm

Ref. Number: **Date : 28-11-2020**

II Meeting of Academic Council, University Departments, RTU, KOTA was convened through online mode on 27-11-2020 at 3:30 PM using Google Meet under the Chairmanship of Prof. A.K. Mathur, Dean, Faculty Affairs. Following members were present:

1. Prof. B.P. Suneja
2. Prof. Rajiv Gupta
3. Prof. Dinesh Birla
4. Prof. S. R. Kapoor
5. Prof. V.K. Gorana
6. Prof. A.K. Chaturvedi
7. Prof. Vivek Pandey
8. Prof. K.S. Grover
9. Dr. R.K.Bayal
10. Dr S. D. Purohit
11. Dr. Sanju Tanwar
12. Shri Manoj Vaishnav
13. Shri Ashok Patni
14. Dr. Vikas Bansal (Member Secretary)

Following agendas related to academic has been discussed and resolved into the meeting:

Agenda 1: Modifications/ improvement in CBCS regulations for Undergraduate programmes

Looking towards the model curriculum provided by the AICTE and to improve the academics of University Departments, RTU, Kota in the prevailing situations, modifications may be made in the CBCS regulations. A committee was formed for modifications in CBCS regulation as decided in the meeting of Head of Departments held in the month of September 2020. The committee has recommended CBCSUG-2020 after incorporating modifications in CBCSUG-2017. CBCSUG-2020 may be affected from the students admitted in 2020-21 and onwards. Modified regulations (CBCSUG-2020) as enclose in Annexure-1 is submitted herewith for approval. These shall be affected from

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the students admitted in 2020-21 and onwards after approval. Members are requested to approve.

Resolution: The Agenda was approved by the respected members. Following modifications were suggested and approved by the respected members in proposed CBCSUG-2020 by the committee (appointed on September 05, 2020 in the meeting of Head of Departments):

i. Industrial Training (as mentioned in Section 6 and other Sections of the proposed CBCSUG-2020) has been considered as Credit courses in place of non-graded core courses. Therefore, 5 non-graded units have been changed to 5 Credits.

ii. As suggested by HVC, SODECA, which was also non-graded core course (as mentioned in Section 6 and other Sections of the proposed CBCSUG-2020), has also been converted to Credit course. Therefore, 4 non-graded units of SODECA have been changed to 4 Credits of SODECA (Anandam).

iii. Above two changes have been resulted into change in the minimum credit requirement criterion (as mentioned in Section 4 and other Sections of the proposed CBCSUG-2020) for passing the B.Tech. degree. Now, minimum credit requirement is 164 Credits along with 11 non- graded units in place of 155 Credits along with 20 non- graded units as suggested by the committee (appointed on September 05, 2020 in the meeting of Head of Departments).

iv. In ADDITION of grades S and Z (as mentioned in Section 6 and other Sections of the proposed CBCSUG-2020), two more grades V for excellent performance and G for good performance has also been.

v. As mentioned in Appendix-1 and other Sections of the proposed CBCSUG-2020, In first year scheme, Engineering Mechanics and Introduction to Electrical and Electronics Engineering has been replace by Basic Mechanical Engineering, Basic Civil Engineering and Introduction to Electrical and Electronics Engineering. Students of CS, EC, EE, EIC, IT will study Basic Mechanical Engineering and Basic Civil Engineering. Students of CE, PE, PC will study Basic Mechanical Engineering and Introduction to Electrical and Electronics Engineering. Students of AE, ME, PIE will study Basic Civil Engineering and Introduction to Electrical and Electronics Engineering.

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vi. As per the guidelines of AICTE and as suggested and approved in the UDAC meeting, Minor degree or Honours shall be added in the B. Tech. degree on completing courses of extra 20 credits in the inter-disciplinary specialization or Departmental specialization respectively. This provision has been placed in place of the option for both Minor degree and Honours (as mentioned in Section 5, Appendix-3 and other Sections of the proposed CBCSUG-2020) on clearing extra 40 credits as suggested by the committee (appointed on September 05, 2020 in the meeting of Head of Departments).

vii. Therefore, the minimum requirement for obtaining Minor degree or Honours (as mentioned in Section 5, Appendix-3 and other Sections of the proposed CBCSUG-2020) with B. Tech. Degree becomes 184 credit and 11 non-graded units.

viii. List of MOOC courses may also be prepared from the option available to the BOS other than 4 agency prescribed in the proposed CBCSUG-2020 (as mentioned in Section 5 and other Sections of the proposed CBCSUG-2020) by the committee. The list of MOOCS prepared by the BOS shall be approved by Dean UD.

ix. The provision for obtaining the grades in the MOOC COURSES as suggested by the committee and as mentioned in Section 5 and other Sections has been replaced by the following provision as suggested and approved by the Hon'ble members that In House examination / evaluation will be carried out for the MOOC COURSES as held for regular courses. The grading of the MOOC courses will be done on the basis of these examinations/evaluations. A Course Coordinator will be assigned for each MOOC COURSE.

x. Theory and Practical courses will be treated as separate courses.

xi. The provision of 'Self-study course' as mentioned at Sub. Section 4.11 of Section 4 of proposed CBCSUG-2020 has been deferred.

xii. The provision of 'Exit policy' as mentioned at Sub. Section 4.13 of Section 4 of proposed CBCSUG-2020 has been deferred till announced by AICTE and other regulating bodies.

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xiii. Minimum number of students in Departmental Elective has been replaced by 'minimum of 10 or actual number of students admitted' in place of '10' (as mentioned in Section 3.3 and other Sections of the proposed CBCSUG-2020).

Agenda 2: To approve B. Tech. Curriculum applicable for students admitted in 2017-18

In pursuance of the CBCS Regulations, the teaching schemes have been revised form 2017-18 by the concerned BOS, these are placed for kind perusal of members (Annexure 2). Members are requested to approve.

Resolution: The Agenda was approved by the respected members.

Agenda 3: To approve B. Tech. Curriculum applicable for students admitted in 2018-19

In Academic session 2018-19, a revised teaching scheme for I and II semester in line with that in RTU was adopted on recommendation of the BOS and approval of the Vice Chancellor .

In the prevailing market conditions and as per the model curriculum provided by AICTE, it has been discussed in the meeting of Head of Departments held in the month of September 2020 to **include One MOOC courses each in VII and VIII semester aggregating to 7 Credit in the scheme for the students admitted in 2018-19.** 8-10 weeks of MOOC courses shall be considered for 3 credits and 12-16 weeks for MOOC courses shall be considered for 4 credits. A list of the MOOC courses shall be submitted by the respective BOS, two months before the start of the respective semester . The students have to select the MOOC courses from the list provided by the concerned BoS. The MOOCs courses available on the following site/platform will be recognized.

Initiative	Institution Behind Platform	Website Link
NPTEL	IIT Madras	nptel.ac.in/
mooKIT	IIT Kanpur	www.mookit.co/
IITBX	IIT Bombay	iitbombayx.in/
SWAYAM	MHRD and Microsoft	Swayam.gov.in

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Only those MOOCs courses will be considered for fulfilling the requirement of the B.Tech. Degree, which have certification.

The student will inform in writing to respective Head of the Department about the MOOCs courses intended to register from the list provided by concerned BoS at the time of registration of other courses. The HOD shall verify the authenticity of the course as per points mentioned above. The student shall submit the certificate along with the credit earn to the HOD, who will ensure to submit the information about the credit and grade earn by the student during the semester (through the MOOCs courses) at the time of submission of other course grades. Before submitting the grade of MOOC course registered by the student, the HOD shall convert the grade of the MOOC course to the grading system of CBCS of University Departments. For conversion, first the grade of the course shall be converted to equivalent marks using the rules prevalent at the institute offering the MOOC course and then marks shall be converted to equivalent grade of CBCS of University Departments.

In pursuance of the CBCS Regulations, the revised teaching schemes are placed for kind perusal of members (Annexure 3). Members are requested to approve.

Resolution: The Agenda was approved by the respected members after having following modifications:

The provision for obtaining the grades in the MOOC COURSES as suggested above has been replaced by the following provision as suggested and approved by the Hon'ble members that In House examination / evaluation will be carried out for the MOOC COURSES as held for regular courses. The grading of the MOOC courses will be done on the basis of these examinations/evaluations. A Course Coordinator will be assigned for each MOOC COURSE.

Agenda 4: To approve B. Tech. Curriculum applicable for students admitted in 2019-20

In Academic session 2019-20, a revised teaching scheme for I and II semester in line with that in RTU was adopted on recommendation of the BOS.

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In the prevailing market conditions and as per the model curriculum provided by AICTE, it has been discussed in the meeting of Head of Departments held in the month of September 2020 to **include One MOOC courses each in VII and VIII semester aggregating to 7 Credit in the scheme for the students admitted in 2019-20.** 8-10 weeks of MOOC courses shall be considered for 3 credits and 12-16 weeks for MOOC courses shall be considered for 4 credits. A list of the MOOC courses shall be submitted by the respective BoS, two months before the start of the respective semester . The students have to select the MOOC courses from the list provided by the concerned BoS. The MOOCs courses available on the following site/platform will be recognized.

Initiative	Institution Behind Platform	Website Link
NPTEL	IIT Madras	nptel.ac.in/
mooKIT	IIT Kanpur	www.mookit.co/
IITBX	IIT Bombay	iitbombayx.in/
SWAYAM	MHRD and Microsoft	Swayam.gov.in

Only those MOOCs courses will be considered for fulfilling the requirement of the B.Tech. Degree, which have certification.

The student will inform in writing to respective Head of the Department about the MOOCs courses intended to register from the list provided by concerned BoS at the time of registration of other courses. The HOD shall verify the authenticity of the course as per points mentioned above. The student shall submit the certificate along with the credit earn to the HOD, who will ensure to submit the information about the credit and grade earn by the student during the semester (through the MOOCs courses) at the time of submission of other course grades. Before submitting the grade of MOOC course registered by the student, the HOD shall convert the grade of the MOOC course to the grading system of CBCS of University Departments. For conversion, first the grade of the course shall be converted to equivalent marks using the rules prevalent at the institute offering the MOOC course and then marks shall be converted to equivalent grade of CBCS of University Departments.

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In pursuance of the CBCS Regulations, the teaching schemes are placed for kind perusal of members (Annexure 3). In pursuance of the CBCS Regulations, the revised teaching schemes are placed for kind perusal of members (Annexure 4). Members are requested to approve.

Resolution: The Agenda was approved by the respected members after having following modifications:

The provision for obtaining the grades in the MOOC COURSES as suggested above has been replaced by the following provision as suggested and approved by the respected members that In House examination / evaluation will be carried out for the MOOC COURSES as held for regular courses. The grading of the MOOC courses will be done on the basis of these examinations/evaluations. A Course Coordinator will be assigned for each MOOC COURSE.

Agenda 5: To approve B. Tech. Curriculum applicable from 2020-21 and onwards for first year

In pursuance of **the revised** CBCS Regulations, the teaching schemes are placed for kind perusal of members (Annexure 5). Members are requested to approve.

Resolution: The Agenda was approved by the respected members after following modifications:

In first year scheme Engineering Mechanics and Introduction to Electrical and Electronics Engineering has been replaced by Basic Mechanical Engineering, Basic Civil Engineering and Introduction to Electrical and Electronics Engineering. Students of CS, EC, EE, EIC, IT will study Basic Mechanical Engineering and Basic Civil Engineering. Students of CE, PE, PC will study Basic Mechanical Engineering and Introduction to Electrical and Electronics Engineering. Students of AE, ME, PIE will study Basic Civil Engineering and Introduction to Electrical and Electronics Engineering.

Agenda 6: To approve BOS of HEAS department.

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In pursuance of CBCS Regulations, the BOS of HEAS department is placed for kind perusal of members (Annexure 6). Members are requested to approve.

Resolution: The Agenda was approved by the respected members.

Agenda 7: To approve policies and guidelines regarding academics and examination which are not in practice during pre COVID periods (Normal circumstances).

The extra ordinary situation arisen due to COVID-19, forces the administration to adopt some policies regarding academics and examination which are not in practice during pre COVID periods. Govt. of Rajasthan, Office of HVC and COE issued some guidelines for the academics and examination process. Members are requested to approve the same for University Departments, RTU, Kota.

Members are requested to approve.

Resolution: The Agenda was approved by the respected members.

Reporting Item:

There are no guidelines for preparation of grades for back /improvement examinations in the present CBCS regulations. A committee was formed and approved by HVC for addressing this issue. Following provisions were proposed by the committee and approved by HVC in 2019 (note-sheet enclosed):

a. If the back exam is conducted with main exam then the grading may be calculated with the main exam students.
b. In case the back exam is conducted separately, then the grading may be calculated along with the previous main exam. However, the grading of the students (awarded already) will remain unaffected.

Resolution: The Agenda was approved by the respected members.

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The meeting ended with a vote of thanks to The Chair

Dr Vikas Bansal
Member Secretary, UDAC)

Prof Anil Mathur
Chairman, UDAC

Copy to:

1. **PS to HVC for Approval in BOM**
2. **Members of UDAC**

Dr Vikas Bansal
Member Secretary, UDAC)

Prof Anil Mathur
Chairman, UDAC

NOTE SHEET

Resolution: The UD scheme and syllabus (Mech. and P&I) for 18-19 and 19-20 were discussed and finalized. Course outcomes and their mapping with Program outcomes are to be updated in the syllabus as per NBA requirement.

Agenda 2. List of MOOC courses to be decided by deptt.

Resolution:

As per agenda for VII & VIII semester of 18-19 scheme a list of possible MOOC courses is to be finalized for student. As VII sem of the UD 18-19 scheme is likely to start from July 2021. Therefore it is resolved that BOS of the deptt. will decide and finalize the list of MOOC courses just before 2 months from start of VII sem. (*)(*)

Meeting ended with vote of thanks to Chair.

20/10/20.
(Dr.V.K.Gorana)

Circulation to all faculty
Email & whatsapp.

(*)(*) Following MOOC courses agencies may also be included in the list provided by academic Cell.

(1) Coursera → www.coursera.org

(2) edx (courses by Harvard & MIT) i.e. www.edx.org.

21/10/20.

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Scheme for B.Tech.- P&IE (Effective for student admitted in first year in 19-20)

P&IE deptt. 20-21 III sem onwards

THEORY & PRACTICAL

Sem	Codes	Proposed Scheme- PIE -UD	Credits	Contact hrs/wk			IA	End term	Total
				L	T	P			
III	3PIU1	Advanced Engineering Mathematics-I	4	3	1	0	50	100	150
	3PIU2	Engineering Thermodynamics	4	3	1	0	50	100	150
	3PIU3	Mechanics of Solid	3	3	0	0	50	100	150
	3PIU4	Material Science & Engineering	3	3	0	0	50	100	150
	3PIU5	Fluid Engineering	3	3	0	0	50	100	150
	3PIU6	Foundry & Welding Technology	2	2	0	0	50	100	150
	3PIU11	Production Practice - I	2	0	0	3	50	25	75
	3PIU12	Introduction to Mechanical Engineering Lab.	1	0	0	2	50	25	75
	3PIU13	Material science & Testing Lab.	1	0	0	2	50	25	75
	3PIU14	Fluid Mechanics Lab.	1	0	0	2	50	25	75
	3PIU20	Extra Curricular & Discipline	1	0	0	0	50		50
		Sub- Total	**25**	**17**	**2**	**9**	**550**	**700**	**1250**

Sem	Codes	Proposed Scheme- PIE -UD	Credits	Contact hrs/wk			IA	End term	Total
				L	T	P			
IV	4PIU1	Advanced Engineering Mathematics-II	4	3	1	0	50	100	150
	4PIU2	Design of Machine Element - I	4	3	1	0	50	100	150
	4PIU3	Work System Design & Ergonomics	3	3	0	0	50	100	150
	4PIU4	Theory of Machines	3	3	0	0	50	100	150
	4PIU5	Machining Sciences	3	3	0	0	50	100	150
	4PIU6	Industrial Management	2	2	0	0	50	100	150
	4PIU11	Production Practice - II	2	0	0	3	50	25	75
	4PIU12	Production Engineering Drawing	2	0	0	3	50	25	75
	4PIU13	Theory of Machines Lab.	1	0	0	2	50	25	75
	4PIU14	Work System Design Lab.	1	0	0	2	50	25	75
	4PIU20	Extra Curricular & Discipline	1	0	0	0	50		50
		Sub- Total	**26**	**17**	**2**	**10**	**550**	**700**	**1250**

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Sem	Codes	Proposed Scheme- PIE -UD	Credits	Contact hrs/wk			IA	End term	Total
				L	T	P			
V	5PIU1	Thermal Engineering	4	3	1	0	50	100	150
	5PIU2	Design of Machine Element - II	4	3	1	0	50	100	150
	5PIU3	Quality Control & Reliability Engineering	3	3	0	0	50	100	150
	5PIU4	Measurement and Metrology	3	3	0	0	50	100	150
	5PIU5.1	Principles of Machine Tools	3	3	0	0	50	100	150
	5PIU5.2	Renewable Energy Systems							
	5PIU5.3	Advanced Welding Technology							
	5PIU6.1	CNC Machines & Programming	2	2	0	0	50	100	150
	5PIU6.2	Management Information system (MIS)							
	5PIU6.3	Statistics for Decision Making							
	5PIU11	Thermal Engineering lab	2	0	0	3	50	25	75
	5PIU12	Machine Tool Design Sessional	1	0	0	2	50	25	75
	5PIU13	Metrology Lab.	1	0	0	2	50	25	75
	5PIU14	Quality Control Lab.	1	0	0	2	50	25	75
	5PIU20	Extra Curricular & Discipline	1	0	0	0	50		50
		Sub- Total	**25**	**17**	**2**	**9**	**550**	**700**	**1250**

Sem	Codes	Proposed Scheme- PIE -UD	Credits	Contact hrs/wk			IA	End term	Total
				L	T	P			
VI	6PIU1	Tool Engineering	4	3	1	0	50	100	150
	6PIU2	Facility Planning	4	3	1	0	50	100	150
	6PIU3	Total Quality Management	3	3	0	0	50	100	150
	6PIU4	Operations Research	3	3	0	0	50	100	150
	6PIU5.1	Micro & Nano Manufacturing	3	3	0	0	50	100	150
	6PIU5.2	Computer Aided Design and Graphics							
	6PIU5.3	Maintenance Management							
	6PIU6.1	Data Analytics	2	2	0	0	50	100	150
	6PIU6.2	Managerial accounting, Finance & Economics							
	6PIU6.3	Design and Manufacturing of Plastic Products							
	6PIU11	Metal cutting Lab.	2	0	0	3	50	25	75
	6PIU12	Industrial Engineering Lab-I	2	0	0	3	50	25	75
	6PIU13	Operations Research Lab.	1	0	0	2	50	25	75
	6PIU14	Statistical lab	1	0	0	2	50	25	75
	6PIU20	Extra Curricular & Discipline	1	0	0	0	50		50
		Sub- Total	**26**	**17**	**2**	**10**	**550**	**700**	**1250**

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Sem	Codes	Proposed Scheme- PIE -UD	Credits	Contact hrs/wk			IA	End term	Total
				L	T	P			
VII	7PIU1	Metal Forming Processes	4	3	1	0	50	100	150
	7PIU2	Operational Planning & Control	4	3	1	0	50	100	150
	7PIU3	Advance Manufacturing Methods	3	3	0	0	50	100	150
	7PIU4	Computer Integrated Manufacturing	3	3	0	0	50	100	150
	7PIU5.1	Modelling & Simulation	3	3	0	0	50	100	150
	7PIU5.2	Supply Chain Management							
	7PIU5.3	Rapid Prototyping							
	7PIU6X	MOOC COURSE	4						
	7PIU11	Metal Forming & Tool Design Lab.	2	0	0	3	50	25	75
	7PIU12	CIMS Lab(CAM, IE & Simulation practicals)	1	0	0	2	50	25	75
	7PIU13	Project Stage -I	1	0	0	2	50	25	75
	7PIU14	Practical training & industrial visit	4	0	0	4	150	75	225
	7PIU20	Extra Curricular & Discipline	1	0	0	0	50		50
		Sub- Total	**30**	**15**	**2**	**11**	**600**	**650**	**1250**

Sem	Codes	Proposed Scheme- PIE -UD	Credits	Contact hrs/wk			IA	End term	Total
				L	T	P			
VIII		**Option-A**							
	8PIU1.1	New Enterprise and Innovation Management	3	3	0	0	50	100	150
	8PIU1.2	Engineering Optimization							
	8PIU2.1	Product Development and Launching	3	3	0	0	50	100	150
	8PIU2.2	Mechatronics and MEMS							
	8PIU3.1	Non-Destructive Evaluation and Testing	3	3	0	0	50	100	150
	8PIU3.2	Fuel cells and Hybrid Engine Technologies							
	8PIU4X	MOOC COURSE	3						
	8PIU13	Seminar	4	0	0	4	150	75	225
	8PIU14	Project Stage-2	12	0	0	18	350	175	525
	8PIU20	Extra Curricular & Discipline	1	0	0	0	50		50

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		Sub- Total	**29**	**9**	**0**	**22**	**700**	**550**	**1250**

Sem	Codes	Proposed Scheme- PIE -UD	Credits	Contact hrs/wk			IA	End term	Total
				L	T	P			
		Option-B							
VIII	8PIU4X	MOOC COURSE	3						
	8PIU13	Seminar	4	0	0	4	150	75	225
	8PIU14	Major Project - Final Stage	21	0	0	36	500	475	975
	8PIU20	Extra Curricular & Discipline	1	0	0	0	50		50
		Sub- Total	**29**	**0**	**0**	**40**	**700**	**550**	**1250**

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Department of Mechanical Engineering

Syllabus

of

Bachelor of Technology

Production & Industrial Engineering

From III to VIII Semester

Effective from Academic session 18-19

for B.Tech.- P& IE (Effective for student admitted in first year in 19-20)

Mechanical deptt. 20-21 III sem onwards

University Teaching Departments

Rajasthan Technical University, Kota

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3PIU1: ADVANCED ENGINEERING MATHEMATICS -1

B.Tech. (P&I) 3rd semester
3L+1T

UNIT	CONTENTS	CONTACT HOURS
I	**Laplace Transform:** Definition and existence of Laplace transform, properties and formulae, unit step function, Dirac Delta function, Heaviside function, inverse Laplace transform, Convolution theorem, application of Laplace transform to ordinary differential equation, solution of integral equations.	10
II	**Fourier Transforms:**Fourier Complex, Sine and Cosine transform, properties and formulae, inverse Fourier transforms, Convolution theorem,application of Fourier transforms to partial ordinary differential equation (One dimensional heat and wave equations).	9
III	**Z-Transform:**Definition,properties and formulae, Convolution theorem, inverse Z-transform, application of Z-transform to difference equation.	7
IV	**Numerical Analysis:**Interpolation,difference operators- forward, backward, central, shift and average operators, Newton's forward and backward interpolation formulae, Gauss's forward and backward interpolation formulae, Stirling's formula, Lagrange interpolation formula for unequal intervals. Inverse interpolation.	7
V	Numerical differentiation by Newton's, Gauss's and Stirling's formula.Numerical integration: Trapezoidal Rule, Simpson's 1/3 and 3/8 Rule. Numerical solution of ODE of first order: Picard's method, Euler's method, Modified Euler's method, Runge-Kutta fourth order method, Milne's Method.	7
	TOTAL	40

TEXT BOOK

1. *Advanced Engineering Mathematics*, Jain and Iyengar, Narosa Publications.
2. *Engineering Mathematics for semesters III and IV*, C.B. Gupta, McGraw Hill Education, India.
3. *Advanced Engineering Mathematics*, Denis Zill and Warren Wright, Jones & Bartlett India Private Limited.
4. *Advanced Engineering Mathematics,*O'neil, Cengage Learning, India.

REFERENCE BOOKS

1. *Advanced Engineering Mathematics*, Irvin Kreyszig, Wiley, India.
2. *Advanced Engineering Mathematics*, M. Greenberg, Pearson Education, India.
3. *Advance Engineering Mathematics*, Potter, Oxford, India.
4. *Engineering Mathematics*, Pal and Bhunia, Oxford, India.
5. *Higher Engineering Mathematics*, B. V. Ramana, McGraw Hill Education, India.
6. *Numerical Methods for Scientific & Engineering Computation*, Jain and Iyengar, Jain, New Age International Publication, India.
7. *A First Course in Numerical Methods*, Uri M Asher and Chen Greif, SIAM Publication, India.
8. *Introductory Methods of Numerical Analysis*, S. S. Sastry, PHI Lerning, India.
9. *Numerical Methods for Engineers*, Chapra, McGraw Hill Education, India.
10. *Engineering Mathematics*,Paras Ram, CBS Publisher, India.

Course outcome

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

CO1: Know the basic concepts of integral transforms (Laplace and Fourier), Z-transform and difference operators along their fundamental properties.

CO2: Calculate the transforms of standard functions and elementary sequences, and work out numerical interpolation, differentiation and integration.

CO3: Apply the integral transforms, Z-transform and numerical methods to variety of problems, including differential, integral and difference equations.

CO4: Analyze the transforms and numerical tools needed to solve the practical problems in various branches of engineering.

CO5:

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1	PSO2
CO1	3	2											1
CO2	3	2											
CO3	2	3											
CO4	2	3											
Average	**2.5**	**2.5**											**1.0**

3PIU2: ENGINEERING THERMODYNAMICS

B.Tech. (P&I) 3rd semester
3L+1T

Unit	Contents	Contact Hours
I	**Basic Concepts and definitions of Thermodynamics**: System, Surroundings, Property, Energy, Thermodynamic Equilibrium, Process, work and modes of work.	2
	Zeroth and First Law of Thermodynamics: Zeroth of Thermodynamics**,** Temperature scale, First law of thermodynamics, First law analysis of some elementary processes. Steady and unsteady flow energy equations.	5
II	**Second Law of Thermodynamics:** Heat engine, Heat pump and refrigerator, Second law of thermodynamics, Equivalence of the Kelvin-Plank and Clausius statements. Reversible and Irreversible Processes, Carnot engine, Efficiency of a Carnot engine, Carnot principle, thermodynamic temperature scale, Clausis Inequality.	4
	Entropy: Entropy, Calculation of Entropy change, Principle of entropy increase. Temperature-Entropy diagram, Second law analysis of a control volume.	3
	Availability: Available energy, Loss in available energy, Availability Function, Irreversibility.	3
III	**Thermodynamic Properties of Fluids:** Pure substance, Concept of Phase, Graphical representation of p-v-T data, Properties of steam. Steam tables, Mollier chart	4
	Ideal Gas and Real Gas: Ideal gas, Real gas, Internal energy, enthalpy and specific heats of an ideal gas, equations of state, Dalton's law of partial pressures, Gibbs Dalton law, Thermodynamic properties of gas mixtures.	4
IV	**Thermodynamic Relations:** Thermodynamic variables, Independent and dependent variables, Maxwell's thermodynamic relations, Thermodynamic relations involving entropy, Thermodynamic relations involving enthalpy and internal energy, Joule-Thomson coefficient, Clapeyron equation.	4
	Power Cycles: Otto cycle, Diesel cycle, Dual cycle, Brayton cycle &Ericsson cycle.	5
V	Vapour power cycle: Rankine cycle, effect of operating conditions on its efficiency, properties of ideal working fluid in vapour power cycle	3
	Reheat cycle, regenerative cycle, bleeding extraction cycle, feed water heating co-generation cycle.	3
	TOTAL	40

TEXT BOOK		
1	Nag P.K., Engineering Thermodynamics, Tata Mc-Graw Hill	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub.**
1	Chattopadhyay P., Engineering Thermodynamics, Oxford University Press.	2011
2	Van G.J. Wylen and Sonntag R.E., Fundamental of Thermodynamics, John Wiley &Sons	2003
3	Cengel Y.A. and. Boles M.A, Thermodynamics-An Engineering Approach, McGraw Hill	2011
4	Jones J.B.&.Dugan R.E, Engineering Thermodynamics, PH of India.	1996
5	Rao Y.V.C., An Introduction to Thermodynamics, Wiley Eastern Ltd.	1993
6	Moran M.J and H.N. Shapiro, Fundamentals of Engineering Thermodynamics, John Wiley and Sons	1996
7	Rogers, Gorden., Engineering Thermodynamics, Pearson Education	1996
8	Kroos & Potter, Thermodynamics for Engineers, Cengage learning	2015
9	Mishra, Engineering Thermodynamics, Cengage learning.	2015

Course outcome

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

CO1: Apply concepts of TD and Zeroth Law in solving numerical problems with relevant units.

CO2: Analyze and evaluate different forms work, heat and other properties by applying 1st Law of TD

CO3: Evaluate COP, EER, Efficiency, temperature and entropy by applying second law of TD and its corollaries.

CO4: : Illustrate problem solving procedure related to pure substances, ideal and real gases using PT, PV, TH diagrams

CO5: Correlate various thermodynamic variables in thermodynamic relations.

Evaluate vapour and gas power cycles, its components and summarize performance on the basis of different parameters

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1 PSO2
CO1	3	3	1									1
CO2	3	3	2	2								2
CO3	3	3	2	2			2					2
CO4	3	3	1									
CO5	3	3	1									
CO6	3	3	2	3			2					2
Average	**3.0**	**3.0**	**1.5**	**2.3**			**2.0**					**1.8**

3PIU3: MECHANICS OF SOLIDS

B.Tech. (P&I) 3rd semester
3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	**Stress and Strain:** Elementary definition of stress and strain, stress-strain relationship, elastic, plastic and visco-elastic behavior of common materials in tension and compression test, stress-strain curves, Hooke's law, Poisson's ratio, elastic constants and their relations for an isotropic hookean material, anisotropic and orthotropic materials.	3
	Tension, compression, shearing stress and strain, thermal stresses, composite bars, equations of static equilibrium, concept of free body diagram. Strain energy due to axial loading.	5
II	**Members Subjected to Flexural Loads:** Theory of simple bending, bending moment and shear force diagrams for different types of static loading and support conditions on beams.	4
	bending stresses, section modulus and transverse shear stress distribution in circular, hollow circular, I, Box, T, angle sections etc. Strain energy due to bending.	5
III	**Principal Planes, Stresses and Strains:** Members subjected to combined axial, bending and torsional loads, maximum normal and shear stresses, concept of equivalent bending and equivalent twisting moments, Mohr's circle of stress and strain.	5
IV	**Torsion:** Torsional shear stress in solid, hollow and stepped circular shafts, angular deflection and power transmission capacity. Strain energy due to torsional loads.	6
	Stability of Equilibrium: Instability and elastic stability, long and short columns, ideal strut, Euler's formula for crippling load for columns of different ends, concept of equivalent length, eccentric loading, Rankine formulae and other empirical relations.	4
V	**Transverse Deflection of Beams:** Relation between deflection, bending moment, shear force and load, transverse deflection of beams and shaft under static loading, area moment method, direct integration method.	6
	Thin-walled Pressure Vessels: Stresses in cylindrical and spherical vessels	2
	TOTAL	**40**

TEXT BOOK		
1	Bansal, R. K., "A Textbook of Strength of Materials Laxmi Publications.	**2010**
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Timoshenko, S.P., and Gere, J.M., "Mechanics of Materials", 2nd Ed., CBS Publishers	**2002**
2	Crandall, S.H., Dahl, N.C., and Lardner, T.J., "An Introduction to the Mechanics of Solids", Tata McGraw-Hill	**1999**
3	Pytel and Kiusalaas, "Mechanics of Materials" Cengage Learning	**2011**
4	Punmia, Jain and Jain, "Mechanics of Materials", Laxmi Publication	**2002**
5	Popov, E.P., Nagarajan, S., and Lu, Z. A., "Mechanics of Materials", 2nd Ed., Prentice-Hall of India	**2002**

Course outcome

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

CO1: Explain the fundamental concept of stress and strain, and the relationship between both in order to solve problems on principle of superposition, compound bars and thermal Stresses.

CO2: Apply the theory of simple bending to seek solution related to the pure and non-uniform bending of beams.

CO3: Analyze the members/structure subjected to combined loading and identify the principal planes/stress/strain.

CO4: Evaluate the torsional stress for various cases of shaft and determine buckling load for column of different end conditions.

CO5: Apply different methods to evaluate deflection of beam and carry out stress analysis of thin pressure vessels.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1	PSO2
CO1	3	2		1									
CO2	3	2		1									
CO3	3	3	1	2									
CO4	3	3	1	1									
CO5	3	3	1	2									
Average	**3.0**	**2.6**	**1.0**	**1.4**									

3PIU4: MATERIAL SCIENCE AND ENGINEERING

B.Tech. (P&I) 3rd semester

3L+0T

Unit	Contents	Contact Hours
I	Crystal structure – BCC, FCC and HCP, unit cell, crystallographic planes and directions, miller indices. Crystal imperfections, point, line, surface and volume defects.	4
	Frank Reed source of dislocation, Elastic & plastic modes of deformation, Bauschinger's effect, slip & twinning, strain hardening, cold/hot working recovery, re-crystallization and grain growth.	4
II	Classification of Engineering Materials: Solidification of metals and of some typical alloys, mechanism of crystallization (I) nuclear formation (ii) crystal growth, general principles of phase transformation in alloys, phase rule and equilibrium diagrams, equilibrium diagram of binary system having complete mutual solubility in liquid state and limited solubility in solid state, binary isomorphous alloy system, Hume-Rothery rule , binary system with limited solid solubility of terminal phase and in which solubility decreases with temperature and also alloy with a peritectic transformation, equilibrium diagram of a system whose components are subject to allotropic change.	5
	Iron carbon equilibrium diagram, phase transformation in the iron carbon diagram, eutectic, peritectic, eutectoid and peritectoid reactions and microstructures.	3
III	Isothermal transformation diagrams –cooling curves superimposed on Isothermal Transformation diagram, critical cooling rate. (i) Formation of Austenite from Pearlite (ii) Transformation of Austenite into Pearlite.	4
	Full annealing, stress relief, spheroidizing – normalizing, hardening and tempering of steel. Hardenability, Jominey end quench test – Austempering, martempering. Case hardening, carburising, nitriding, cyaniding, carbonitriding. Flame and Induction hardening.	4
IV	Non-Metallic Materials- Polymers – types of polymer, commodity & engineering polymers – Properties & applications of PE, PP, PS, PVC, PMMA, PET, PC, PA, ABS, PI, PAI, PPO,PPS, PEEK, PTFE Polymers. Urea & Phenol formaldehydes.	4
	Constitution of alloys: Solid solutions - substitutional and interstitial. Ferrous and Non Ferrous Metals- Effect of alloying additions on steel (Mn, Si, Cr, Mo, V, Ti & W) - stainless and tool steels – HSLA steel.	4
V	Mechanical Properties and Testing: Types of fracture, testing of materials under tension, compression and shear loads – hardness tests (Brinell, Vickers and Rockwell) Impact test Izod and charpy, fatigue and creep test.	4
	Classification of steels & cast iron. constitution and properties. BIS standards. Engineering Ceramics – Properties and applications of Al2O3, SiC, Si3N4, PSZ etc. Fiber and particulate reinforced composites and resin plastics. Introduction to Nano materials- Nano structured materials. Nano clusters & Nano crystals.	4
		40

TEXT BOOK		
1	Material Science and Engineering An Introduction, William D.Callister, John Wiley and Sons.	2003
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub.**
1	Material Science, Raghvan V., Prentice Hall India	2012
2	Principles of Material Science and Engineering, William F.Smith, Tata McGraw-Hill Publications.	2008
3	Engineering Physical Metallurgy, Lakhtin Y., Mir Publisher.	
4	Introduction to Engineering materials Tata McGraw-Hill Publications.	2011
6	Material Science and Engineering properties, Gilmore, Cengage Learning	2015

Course outcome

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

CO1: Explain and memorize concept of crystal structure, crystal defects and their effect on the properties of the different type of materials

CO2: Discuss analyze and draw the various types of Equilibrium diagrams. Evaluate the composition of various microstructures using Lever rule.

CO3: Illustrate the concept of heat treatment and explain the effect on properties of the material with different heat treatment processes

CO4: Compare and describe the properties of polymers, types of solid solutions and the effect of alloying elements on steels

CO5: Describe the various types of mechanical properties, methods of testing, classification of steel. Discuss the basic concept of engineering ceramics and nanomaterial

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1	PSO2
CO1	3	3	1										1
CO2	3	3	2	2									1
CO3	3	3	2	1			2						1
CO4	3	3	2	1			2						1
CO5	3	3	2	1			2						1

3PIU5: FLUID ENGINEERING

B.Tech. (P&I) 3rd Semester
3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	**Fluid Properties**: Definition of a fluid, Viscosity-dynamic and kinematic, Surface Tension.	3
	Fluid Statics: Basic equation of fluid statics, Manometers, Force on plane areas and curved surfaces, center of pressure, Buoyant force, Stability of floating and submerged bodies.	5
II	**Fluid flow concepts and Basic control volume equations**: General control equation, conservation of mass, energy equation and its application, Momentum equation and its applications	4
	Basic governing differential equation: Reynolds transport equation, continuity equation, momentum equation, energy equation, Bernoulli's equation.	4
III	**Viscous flow:** Laminar flow through pipe and between parallel plate.	4
	Turbulent flow: Relation, Prandle mixing length, Losses in open and closed conduit	4
IV	**Measurements**: Pressure, velocity, flow measurement-orifices, venturimenter, orificemeter, nozzle meter, notches and weirs.	3
	Flow through pipe: Major and minor Losses in pipe, Hydraulic and energy gradient line, Network of pipes-series and parallel.	5
V	**Hydraulic Turbines:** Classification of hydraulic turbines, work done and efficiencies of Pelton, Francis and Kaplan turbines, Draft tube, Specific speed and unit quantities	5
	Hydraulic systems: Hydraulic press, Hydraulic accumulator, Hydraulic Intensifier, Hydraulic Ram, Hydraulic lift, Hydraulic coupling, Hydraulic torque convertor Gear pump.	3
	TOTAL	40

TEXT BOOK		
1	Yunus A. Cengel and Cimbala, Fluid Mechanics, Tata McGrawHill,	**2006**
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub.**
1	Streeter V.L., K.W. Bedford and E.B.Wylie , Fluid Mechanics , TMH	**2010**
2	Robert W. Fox and Alan T. McDonald, Introduction to Fluid Mechanics, John Wiley & Sons.	**2009**
3	Potter, Mechanics of Fluids, Cengage Learning.	**2012**
4	Frank M. White, Fluid Mechanics, Tata McGraw Hill.	**2003**
5	John F. Douglas, Fluid Mechanics, Pearson Education.	**2007**
6	Munson, B. R., Young, D. F., & Okiishi, T. H. Fundamentals of Fluid Mechanics, Wiley	
7	Som, S. K., & Biswas, G. Introduction to fluid mechanics and fluid machines, Tata McGraw Hill.	**2010**
8	K.Subramaanya, Hydraulic Machines, McGrawhill,	**2013**
9	Modi and Seth, Fluid Mechanics and Hydraulic Machinery, Standard Book House	**1991**

Course outcome

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

CO1: Identify and calculate the key fluid properties used in the analysis of fluid behavior. Describe and apply the principles of pressure, pressure measurement, fluid statics, buoyancy and floatation.

CO2: Apply and deduce the concept of basic governing differential equation of conservation of mass, energy and momentum alongwith their application

CO3: Describe and analyze viscous and turbulent flow.

CO4: Understand and apply the principle of Bernoulliβ€™s equation for fluid flow measurement and to identify the major and minor energy losses that is involved in a fluid flow and their accountability.

CO5: Study and analysis of hydraulic turbines, Hydraulic press, Hydraulic accumulator, Hydraulic Intensifier, Hydraulic Ram, Hydraulic lift, Hydraulic coupling, Hydraulic torque convertor Gear pump.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1	PSO2
CO1	3	3	3	2									1
CO2	3	3	3	2									1
CO3	3	3	3	2									1
CO4	3	3	2	2			2						1
CO5	3	3	2	2			2						1
Average	**3.0**		**3.0**	**2.6**	**2.0**	**2.0**	**1.0**						

3PIU6: FOUNDRY AND WELDING TECHNOLOGY

B.Tech. (P&I) 3rd semester
2L+0T

Unit	Contents	Contact Hours
I	General Classification and Introduction to Manufacturing processes. **Pattern Practice:** Introduction, advantage and disadvantages of casting over other manufacturing process, conventional casting procedure, requirement of a good pattern, types of patterns, pattern materials, pattern allowances.	3
	Moulding Practice: Moulding sands: types, composition, preparation, properties, conditioning and testing - Grain fineness; moisture content, clay content and permeability test.; types of moulds, moulding processes, moulding machines; Cores: Functions of core, type of cores, core print, core box, Gating system: types, pouring basin, sprue, gating ratio, chills, runner and risers; Gating system design and risering design, pouring time.	5
II	**Casting Practice:**Basic rules for good casting design, Foundry equipment and furnaces. Melting, pouring and solidification. relative advantages, disadvantages and applications of casting processes, Sand casting,	3
	shell-mould casting, plaster-mould casting, ceramic-mould casting, vacuum casting, evaporative pattern casting (lost foam), Investment casting, slush casting, die casting, centrifugal casting, continuous casting.	3
	Cleaning, finishing and heat treatment of casting	2
III	**Welding processes**: Introduction, advantages, disadvantages and application of welding, Classification of welding process; Types of joints, welding joint, safety feature in welding, weldability, welding symbols, soldering and brazing.	4
	Welding electrodes, selection of welding electrodes, flux. Pressure welding: forge welding, resistance electric welding, butt welding, flash welding, spot welding, seam welding, projection welding. Fusion welding: gas welding, electric arc welding, metallic arc welding, carbon arc welding, shielded arc welding, Thermit welding.	4
IV	TIG welding, MIG welding, submerged arc welding, ultrasonic welding, plasma arc welding, laser beam welding, friction welding, cold welding, under water welding.	3
	Thermal cutting of metals, welding of dissimilar metals, welding of plastics, Residual welding stresses, heat treatment of weldments,	5
V	**Testing of Castings and Weldments:** Causes and remedies for casting defects, welding defects. Destructive testing methods: tensile test, compression test, bend test, impact test, hardness test.	4
	Non destructive testing methods: visual inspection, leak test, x-ray and X-ray radiography, magnetic particle test, liquid penetration test, fluorescent penetration test, ultrasonic test, eddy-current test, allowable defects and quality control of welding as per ASME standard.	4
	TOTAL	40

TEXT BOOK		
1	Rao.P.N., Manufacturing Technology, Vol. 1, Tata McGraw Hill	2013
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub.**
1	Ghosh, A., & Mallik, A. K. 1986. Manufacturing Science: Ellis Horwood.	1999
2	Schey, Introduction to Manufacturing Processes, Tata McGraw Hill	2000
3	Kalpakjian, S., & Schmid, S. R., Manufacturing processes for engineering materials, Pearson Education.	2008
4	Campbell, J. S. Principles of manufacturing materials and processes: TMH	1999
5	Heine,, Loper, C.R., and Rosenthal, P.C., "Principles of Metal casting", TMH	1976
6	Groover, M.P., Fundamentals of Modern Manufacturing: Materials, Processes and systems, Prentice Hall, New Jersey	2007

7	Kalpakjian, S. & Schmid S.R, Manufacturing Engineering and Technology, Addison Wesley Longman	**2000**
8	Little, R.L., Welding and welding technology Tata McGraw-Hill Education	**1973**
9	Shan, H.S., Manufacturing Process, Pearson Education.	**2012**
10	Principle of Foundry Technology , P.L.Jain, Tata McGraw Hill, 2003	
11	Modern Welding Technology, B.Curry, Prentice Hall,	2002
12	Welding Principle & applications ,Larry Jeff in Delmar,	1997
13	Foundry Engineering ,Taylor HF Fleming, M.C. & Wiley Eastern Ltd.	

Course outcome

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

CO1: To deal with various casting processes such as sand casting , permanent casting etc.

CO2: To deal with forming processes like, rolling, extrusion, forging, and their applications.

CO3: Recognize the various techniques of welding and solve engineering problems in welding .

CO4: Understanding of powder manufacturing process and its application.

CO5: Knowledge of various Castings and welding defects and identification of these defects by using various techniques.

CO-PO Mapping

Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO1**	**PO1**	**PO1**	**PSO1**	**PSO2**
CO1	3	2	2	2	2									
CO2	3	2	2	2	1									
CO3	3	2	1	2	2									
CO4	3	2	2	2	2									

3PIU11: PRODUCTION PRACTICE-I

B.Tech. (P&I) 3rd Semester
0L+0T+3P

SN	NAME OF EXPERIMENT	
	Machine Shop	
1	To study lathe machine construction and various parts including attachments, lathe tools cutting speed, feed and depth of cut.	
2	To perform step turning, knurling and chamfering on lathe machine as per drawing.	
3	To perform taper turning (a) by tailstock offset method as per drawing (b) Using compound rest.	
4	To prepare the job by eccentric turning on lathe machine.	
5	To study shaper machine, its mechanism and calculate quick return ratio. To prepare a job on shaper from given mild steel rod.	
	Foundry Shop	
6	To prepare mould of a given pattern requiring core and to cast it in aluminum.	
7	To perform moisture test and clay content test.	
8	Strength Test (compressive, Tensile, Shear Transverse etc. in green and dry conditions) and Hardness Test (Mould and Core).	
9	To perform permeability test	
10	A.F.S. Sieve analysis test.	
	Welding Shop	
11	Hands-on practice on spot welding.	
12	Hands-on practice on submerged arc welding	
13	Hands-on practice on metal inert gas welding (MIG) and tungsten inert gas welding (TIG).	

Course outcome

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

CO1: To learn parametric aspects of machining, working principle and machining process.

CO2: Learn and practice the machining operation and tools used in machining.

CO3: Understand and perform sand mould testing methods.

CO4: Learn and perform the gas, arc, spot welding operations.

CO5: Learn to operate the machine used in mechanical engineering workshop.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1	PSO2
CO1	3	2	2			1							
CO2	3	3											
CO3	3	3				1							
CO4	3	3	2			2							
CO5	3	3	3			1							
Average	**3.0**	**2.8**	**2.3**			**1.3**							

3PIU12: INTRODUCTION TO MECHANICAL ENGINEERING LAB

B.Tech. (P&I) 3rd Semester

0L+0T+2P

SN	LABORATORY WORK	
	Exposure to a wide range of applications of mechanical engineering through a variety of activities, including hands-on assembly and disassembly of machines, such as, bicycle, sewing machine, pumps, engines, air-conditioners, machine-tools, amongst others; observational study of complex systems via cut sections, visits, videos and computer simulations; design of simple machines/systems including specifications formulation; visits to industries.	
	Note: Student will be required to submit written report indicating the learning achieved by Hands on assembly/Disassembly.	

Course outcome

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

CO1: Demonstrate and explain the wide range of applications of basic mechanical engineering systems

CO2: Explain the construction of various mechanical machines by assembly disassembly, cut sections and animations.

CO3: Determine and identify the specifications of mechanical machines.

CO4:

CO5:

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1	PSO2
CO1	2	2	1										
CO2	2	2	1		2								
CO3	2	2	1		2								
Average	**2.0**	**2.0**	**1.0**		**2.0**								

3PIU13: MATERIAL SCIENCE AND TESTING LAB.

B.Tech. (P&I) 3rd Semester
0L+0T+2P

SN	NAME OF EXPERIMENT	
1	(a) Study of various crystals structures through models BCC, FCC, HCP, tetrahedral and octahedral voids. (b) Material identification of, say, 50 common items kept in a box.	
2	Specimen preparation for metallographic examination /micro structural examination-cutting, grinding, polishing, etching.	
3	Comparative study of microstructures of different given specimens (mild steel, gray C.I., brass, copper etc.)	
4	Heat treatment experiments such as annealing, normalizing, quenching, case hardening and comparison of hardness before and after.	
5	Study of Microstructure and hardness of steel at different rates of cooling. Microstructure examination of white cast iron.	
6	To perform Tensile/Compressive/Shear/torsion test on a given material and to determine its various mechanical properties under tensile/compression/Shear/torsional loading	
7	To determine Rockwell/ Vickers/Brinell hardness of a given material	
8	To perform Impact test on a given material and to determine its resilience.	
9	To study and perform Fatigue test on a given material and to determine fatigue strength of the material	
10	To perform Bending test and to determine the Young's Modulus of Elasticity via deflection of beam.	
11	Creep testing on creep testing machine	

REFERENCE BOOKS		
SN	Name of Authors /Books /Publisher	**Year of Pub.**
1	Vander Voort, Metallography: Principles and Practice, McGraw-Hill	**1984**
2	Prabhudev K.H., Handbook of Heat Treatment of Steels, Tata McGraw-Hill	**2000**
3	Suryanarayanan, A.V.K. "Testing of Metalic materials" TataMcGraw Hill	**1993**

Course outcome

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

CO1: Illustrate the concept of crystal structure, crystal defects and their effect on the properties of the materials and also to identify different materials.

CO2: Conduct Hardness & Impact tests

CO3: Compare and illustrate the properties of materials after heat treatment and comparison of hardness before and after heat treatment

CO4: Study and compare microstructures of different given specimens (mild steel, gray C.I., brass, copper etc.).

CO5: Study of Tension, Compression, Bending & Shear tests on UTM and evaluate material properties

Study of metallographic /micro structural properties of various materials after polishing and etching process

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1 PSO2
CO1	3	3	2	1			1					2
CO2	3	3	2	1			1					2
CO3	3	3	2	2			1					2
CO4	3	3	2	2			1					2
CO5	3	3	2	2			1					2
CO6	3	3	2	3			1					2
Average	**3.0**	**3.0**	**2.0**	**1.8**			**1.0**					**2.0**

3PIU14: FLUID MECHANICS LAB.

B.Tech. (P&I) 3rd Semester
0L+0T+2P

SN	NAME OF EXPERIMENT
1	Determination of Meta-centric height of a given body.
2	Determination of Cd, Cv & Cc for given orifice.
3	Calibration of contracted Rectangular Notch and / Triangular Notch and determination of flow rate.
4	Determination of velocity of water by Pitot tube.
5	Verification of Bernoulli's theorem.
6	Calibration and flow rate determination using Venturimeter & Orifice meter and Nozzle meter
7	Determination of head loss in given length of pipe.
8	Determination of the Reynold's number for laminar, turbulent and transient flow in pipe.
9	Determination of Coefficient for minor losses in pipes.
10	To study the velocity distribution in a pipe and also to compute the discharge by integrating the velocity profile.
11	To study the boundary layer velocity profile over a flat plate and to determine the boundary layer thickness.

Course outcome

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

CO1: develop procedure for standardization of experiments

CO2: calibrate flow discharge measuring device used in pipes channels and tanks

CO3: determine fluid and flow properties

CO4: illustrate laminar and turbulent flows

CO5: test the performance parameters for flow through pipes

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1	PSO2
CO1	3	2	2	3	2								
CO2	3	3	2	3	3								
CO3	3	3	2	3	3								
CO4	3	2	2	3	2								
CO5	3	3	2	3	2								
Average	**3.0**	**2.6**	**2.0**	**3.0**	**2.4**								

3PIU20: DISCIPLINE AND EXTRA CURRICULAR ACTIVITIES

Course outcome

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

CO1: Recognize their strength and those of others to work towards a shared vision (leadership)

CO2: Develop and sustain healthy and meaningful relationship with others (Interpersonal skills)

CO3: Identify and address the needs of the community collaboratively to facilitate positive social change (Social Responsibility)

CO4: Generate innovations through experimentation with novel ideas, forms, and methods (Critical and creative thinking)

CO5: Act as a disciplined citizen with ethical and moral values

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1 PSO2
CO1						2	1	3	2	1		2
CO2						2	1	2	3	3		1
CO3						3	2	2	2	2		2
CO4	3	2	2	2	2		1		2	1		2
CO5						2	1	3	1	1		2
Average	**3.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.3**	**1.2**	**2.5**	**2.0**	**1.6**		**1.8**

4PIU1: ADVANCED ENGINEERING MATHEMATICS -II

B.Tech. (P&IE) 4th semester

3L+1T

UNIT	CONTENTS	CONTACT HOURS
	Complex Analysis: Differentiability and Analytic functions, Cauchy-Riemann equations (Cartesian and Polar forms), Harmonic functions. Conformal mapping.	**9**
	Complex Line integral, M-L inequality, Cauchy theorem, Morera's theorem, Cauchy integral formulae, Taylor series and Laurent series. Singularities and Zeros, residues at poles and infinity, residues at isolated essential singular point, Cauchy residue theorem, evaluation of real definite integrals and improper integrals.	**8**
	Special Functions: Legendre's function, Rodrigues formula, generating function, Simple recurrence relations, orthogonal property. Bessel's functions of first and second kind, generating function, simple recurrence relations, orthogonal property.	**8**
	Statistics & Probability: Basic concepts of probability, conditional probability, Baye's theorem. Random variable and distributions: Discrete and continuous random variables, Moments, Expectation, Moment generating function, Binomial, Poisson and Normal distribution.	**9**

TEXT BOOK

SN	Name of Authors /Books /Publisher	Year of Pub.
1	Advanced Engineering Mathematics, Jain and Iyengar, Narosa Publications.	
2	Advanced Engineering Mathematics, Denis Zill and Warren Wright, Jones & Bartlett India Private Limited.	
3	Introduction to Probability and Statistics, Seymour Lipschutz and John J. Schiller, McGraw Hill Education, India.	
4	Advanced Engineering Mathematics,O'neil, Cengage Learning, India.	

REFERENCE BOOKS

SN	Name of Authors /Books /Publisher	Year of Pub.
1	Advanced Engineering Mathematics, Irvin Kreyszig, Wiley, India.	
2	Advanced Engineering Mathematics, M. Greenberg, Pearson Education,	
3	Advance Engineering Mathematics, Potter, Oxford, India.	
4	Engineering Mathematics, Pal and Bhunia, Oxford, India.	
5	Higher Engineering Mathematics, B.V. Ramana, McGraw Hill Education, I	
6	Complex Variables and Applications, J.W. Brown & R.V. Churchill, MHI	
7	Probability and Statistics, Murray Spiegel, John Schiller, R. AluSrinivasan, McGraw Hill Education, India.	
8	Engineering Mathematics,Paras Ram, CBS Publisher, India.	

CO1: Solve various functions through complex analysis.
CO2: Apply different series and theorem to solve complex integrals.
CO3: Understand various special functions.
CO4: Analyze various probability methods and distributions.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	-	-	-	-	-	-	-	-
CO2	3	2	1	2	-	-	-	-	-	-	-	-
CO3	3	3	3	2	-	-	-	-	-	-	-	-
CO4	3	2	2	3	-	-	-	-	-	-	-	-

4PIU2: DESIGN OF MACHINE ELEMENTS – I

B.Tech. (P&I) 4th semester
3L+1T

UNIT	CONTENTS	CONTACT HOURS
I	**Design Criteria:** Strength, Stiffness, aesthetics, ergonomics Design for Manufacturing: Design consideration for cast, forged and machined parts. **Theories of Elastic Failures:** The necessity for a theory, different theories, significance and comparison, applications **Design for Assembly:** Introduction, Limits, fits and tolerances, Interchangeability, standardization. **Materials:**Selection of material from properties and economic aspects. Mechanical Properties and IS coding of various materials,	7
II	**Design for Strength**: Modes of failure, Allowable stresses, factor of safety. **Stress concentration:** causes and mitigation.	4
	Design of Members subjected to direct stress: Knuckle and cotter joints.	5
III	**Design of Members in Bending**: Levers and laminated springs. **Design for stiffness:**Introduction, Specific cases of beam designon the basis ofmaximum deflection.	7
IV	**Design of Members in Torsion:** Solid and hollow shafts. Shafts under combined loading. Sunk keys.	5
	Couplings*:* Design of muff coupling, flanged couplings: rigid and flexible	3
V	**Design of Threaded fasteners**: Bolt of uniform strength, Preloading of bolts: Effect of initial tension and applied loads, Eccentric loading	5
	Power transmission: Belts and ropes, effect of centrifugal force and creep. Design of flat and Vee belts.	4
	TOTAL	40

TEXT BOOK		
1	Bhandari, V. B., Introduction to Machine Design, McGraw Hill Education (India)	2013
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Bahl and Goel, Mechanical Machine Design, Standard Publishers Distributors	2002
2	Shigley, Joseph E., Mechanical Engineering Design, McGraw Hill Education (India)	2002
3	Sharma and Aggarwal, Machine Design, S.K.Kataria and Sons, Delhi.	1997
4	Sharma and Purohit, Design of Machine Elements, Prentice Hall India.	2002
5	Jindal U C, Machine Design, Pearson Education India	2010

Course outcome

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

CO1: Describe various design criteria and explain material and failure theories.

CO2: Determine the sizes of the parts of cotter and knuckle joints considering various modes of failure.

CO3: Design the bending members like Lever and laminated spring based on strength and stiffness consideration.

CO4: Design the shaft and shaft - coupling under torsional loading.

CO5: Compute and select the bolt size for different loading conditions.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1 PSO2
CO1	3	2	2	1								
CO2	2	3	3	1								
CO3	2	3	3	1								
CO4	2	3	3	1								
CO5	2	3	2	1								
Average	**2.2**	**2.8**	**2.6**	**1.0**								

4PIU3: WORK SYSTEM DESIGN AND ERGONOMICS

B.Tech. (P&I) 3rd semester
3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	Concept of Productivity, effectiveness and efficiency, work components of manufacturing time and work content, factors tending to reduce productivity, reducing work content and ineffective time.	3
	Work Study: Objectives of work study - work study procedure human factors in the application of work study-relationship between method study and work measurement.	5
II	**Method Study**: General principles - basic steps-criteria for selecting work-samples and techniques – data collection-critical evaluation-brain storming and creativity-development of new methods and installation principles of layout of material handling	4
	Principles of motion economy-work place layout-examples of method study in plants and offices. Work place and work environment design.	4
III	**Work Measurement**: Introduction to work measurement, purpose-use of work measurement-basic procedure-time study equipment's-selection of jobs to be studied-approach to workers-steps in making a time study-number of cycles to be studied.	5
	Performance rating and allowances: Rating-use of rating factor-allowances-personal allowance, fatigue allowance-compiling allowed time for a job - examples of time study-synthesis from standard data. Use of work measurement techniques	4
IV	Work sampling, Theory; determination of number of observations needed, confidence limits-area of application limitations-systematic work sampling and random work sampling.	5
	Ancillary techniques: Pre-determined Motion standards, MTM and work factor-design of work place, design of fixtures and equipment's, standard data, TMU formula, job evaluation and merit rating.	3
V	**Ergonomics**: The nature of Ergonomics; Ergonomics practice Systems concepts. Human body measurement (Anthropometry).	5
	Joints, bones, muscles. Layout of equipment. Seat design. Design of controls and compatibility.	3
	TOTAL	40

TEXT BOOK

1	Motion and Time Study and Measurement of Work, Ralph, M Barnes , John Wiley and Sons.	2001

REFERENCE BOOKS

SN	Name of Authors /Books /Publisher	Year of Pub.
1	Human Factors Engineering and Design, M.S.Saunders and E.J. McCormic, McGraw Hill.	1995
2	Introduction to Work Study, George Kanawaty, ILO.	2002
3	Industrial Engineering Handbook , Harold Bright Maynard, Kjell B. Zandin, McGraw-Hill.	1998
4	Work measurement and methods improvement, Lawrence S. Aft, Wiley-IEEE.	2002
5	"Niebel's Methods, Standards, and Work Design", Benjamin W. Niebel, Freivalds Andris, McGraw Hill Education (India).	2008
6	Motion and time study: improving productivity, Marvin Everett Mundel, Prentice-Hall.	2003

Course outcome

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

CO1: Describe the basic concept of productivity and work study.

CO2: Describe principles of method study, motion economy & apply in work place design

CO3: describe procedure of work measurement and estimate work performance.

CO4: Apply theory of work sampling, PMTS and job evaluations

CO5: draw significance between Ergonomics and work system design

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1	PSO2
CO1	2	1											
CO2	2	2											
CO3		1	2	2									
CO4			3	2	3								
CO5					2								
Average	**2.0**	**1.3**	**2.5**	**2.0**	**2.5**								

4PIU4: THEORY OF MACHINES

B.Tech. (P&I) 4th semester
3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	**Introduction to mechanism:** Basic concept of machines, links, kinematic pair, kinematic chain and mechanism. Inversions of kinematic chains: four bar chain mechanisms, quick return mechanisms, inversions of double slider crank mechanisms.	5
	Velocity and acceleration in mechanism: Velocity and acceleration polygons, relative velocity and instantaneous centre method	3
II	**Friction devices:** Types and laws of friction. Pivots and collars. Power screws such as lead screw of the lathe.	4
	Clutches: Single and multi-plate clutches. **Brakes:** Band, block and band and block brakes.	4
III	**Gears:** Laws of gearing, gears terminology; tooth form; interference, undercutting and minimum number of teeth on pinion. Rack and pinion, Spur, helical, basic introduction of bevel, worm and worm gears,.	6
	Gear Trains: Simple, compound and epicyclic gear trains.	3
IV	**Cams:** Type of cams; displacement, velocity and acceleration curves for different cam followers; consideration of pressure angle and wear.	4
	Gyroscope: Principles of gyroscopic couple, effect of gyroscopic couple and centrifugal force on vehicles taking a turn, stabilization of ship.	4
V	**Balancing:** Balancing of rotating masses in same and different planes, balancing of reciprocating masses, swaying couple, hammer blow and tractive effort.	7
	TOTAL	**40**

TEXT BOOK		
1	Rattan, S.S., "Theory of Machines", 2nd Ed., Tata McGraw Hill	2006
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Bevan, T., "Theory of Machines", Pearson Education.	2013
2	Uicker, J.J., Pennocle, G.R, and Shigley, J.E, "Theory of Machines and Mechanisms", 3rd Ed., Oxford University Press.	2009
3	Ambekar , A. G., "Mechanism And Machine Theory", Prentice-hall Of India	2007
4	Ghosh, A., "Theory of Mechanisms and Machines", Affiliated East West Press.	
5	Singh, S., "Theory of Machines", Pearson Education	2013
6	Stanisic., "Mechanisms and Machines-Kinematics, Dynamics & Synthesis", Cengage leasrning	2014

Course outcome

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

CO1: Learn the basic concept of machine and different mechanism & sketch velocity and acceleration diagrams.

CO2: Apply the concept of friction in brakes, clutches and dyanamometers.

CO3: Identify appropriate gear and gear train for particular applications.

CO4: Explain the gyroscopic effect. Construct/sketch the cam profile for different follower motion.

CO5: Solve problems of balancing of rotating and reciprocating masses.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1	PSO2
CO1	2	3											
CO2	3	3											
CO3	2	3	2										
CO4	3	3											
CO5	2	3	2	2									
Average	**2.4**	**3.0**	**2.0**	**2.0**									

4PIU5: MACHINING SCIENCES

B.Tech. (P&I) 4th semester
3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	Classification of metal removal process and Classification of machine tools, Geometry of single point cutting tool and tool angles, tool nomenclature in ASA and ORS. Concept of orthogonal and oblique cutting.	5
II	Chip Formation, Mechanics of metal cutting, shear angle and its relevance, various theories of metal cutting. Thermal aspects of machining and measurement of chip tool interface temperature. machinability, tool wear, tool life, Cutting fluids, Economics of machining, Measurement of cutting forces.	2
III	Lathe: Construction and cutting speed, feed, and depth of cut, machining time and power estimation. Capstan and turret lathe machines, tool layout. Shaper: Construction and working principle, Quick return mechanism.	4
	Milling: Introduction, types of milling machines, milling cutters, milling operations, dividing head, Indexing methods, machining time and power estimation and gear cutting.	4
IV	Gear hobbing, gear shaping. Gear finishing processes: shaving, grinding, lapping and shot blasting	3
	Drilling: - tool geometry of twist drills, types of drills, drilling machine construction, drilling time and force estimation	5
V	Grinding- Need and different methods of grinding, grinding wheel designation and selection, Dressing and truing, Types of grinding machines, Grinding process. Honing, lapping, super finishing, polishing and buffing processes.	4

TEXT BOOK		
1	Lal G.K., Introduction to Machining Science, New Age international Publishers.	**2007**
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub.**
1	Rao.P.N., Manufacturing Technology, Vol. 1,2 and 3, Tata McGraw Hill	**2013**
2	Ghosh, A., & Mallik, A. K.. Manufacturing Science: East West Press Private Limited.	**1986**
3	Schey, Introduction to Manufacturing Processes, Tata McGraw Hill	**2000**
4	Kalpakjian, S., & Schmid, S. R., Manufacturing processes for engineering materials, Pearson Education.	**2008**
5	Pandey & Singh, Production Engineering Science, Standard Publishers Distributer, Delhi.	**1999**
6	Stephenson, D. A., & Agapiou, J. S. Metal cutting theory and practice: CRC Taylor & Francis.	**2006**
7	Karl H.Heller, All About Machine Tools, Wiley Eastern Ltd., New Delhi	**1972**
8	Kalpakjian, S. & Schmid S.R, Manufacturing Engineering and Technology, Addison Wesley Pub. Co.	**2000**
9	Sen, G. C., & Bhattacharyya, A. Principles of Machine Tools: New Central Book Agency	**1988**
10	Bhattacharyya A, Theory & Practice of Metal Cutting, New Central Book Agency	**2006**
11	Shan, H.S., Manufacturing Process, Pearson Education.	**2012**
12	Boothroyd, G., & Knight, W. A. Fundamentals of machining and machine tools: Taylor and Francis.	**2006**
13	Milton C. Shaw, Metal Cutting Principles, CBS Publishers.	**2005**
14	Trent, E. M. Metal cutting: Butterworth Heinemann	**2000**

CO1: Acquires the fundamental knowledge and principles in material removal processes.
CO2: Demonstrate the fundamentals of machining, finishing, SPM processes and machine tools.
CO3: Evaluate the importance of input and output metal cutting parameters.
CO4: Learn about tool materials, cutting fluid and tool wear mode / mechanism.
CO5: Understand and analyse about high velocity forming methods.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	3	2	3	-	-	-	-	-	-	-	-
C02	3	3	3	2	-	-	-	-	-	-	-	-
C03	3	2	3	2	-	-	-	-	-	-	-	-
C04	3	3	3	3	-	-	-	-	-	-	-	-
CO5	3	2	3	2	-	-	-	-	-	-	-	-

4PIU6: INDUSTRIAL MANAGEMENT

B.Tech. (P&I) 4th Semester

2L+0T

Unit	Contents	Contact Hours
I	Management: Definition including conceptual analysis, functions. Evolution of management thought, scientific management, contributions of Taylor, Gilbert, Gantt, Elton Mayo, Henry Fayol and others.	5
	Management process & systems approach to Management, functions of managers. Levels of management, Administration & Mnmgt. Decision making.	3
II	Forms of ownership: Proprietorship, partnership, joint stock company, private and public limited companies, Joint Stock Companies: Co -operative Society, choice of business forms and state undertakings. Multinational corporations.	4
	Management Planning: Managerial planning, Type of plans, steps in planning; mission, objectives, strategies, policies, procedures, rules and programs. Managing by objectives, strategic planning process, SWOT analysis.	4
III	Organizing: Meaning of organizing and organization, formal and informal organization, span of management, process of organizing. Organizational structure: Line organization, functional organization, matrix organization, strategic business units. Line/Staff concepts, empowerment, and decentralization, delegation of authority.	5
	Effective organizing and organizational culture. Staffing: overview, factors affecting staffing, systems approach, job design, selection, Performance appraisal, rewards. Career strategy, managerial training. Managing change.	4
IV	Human factors in managing Motivation : Theory X, Theory Y, Maslow's hierarchy of needs, Hertzberg's hygiene theory, porter and Lawler model, equity theory, Reinforcement theory, McClelland's theory behavioral model.	5
	Motivational techniques, job enrichment. Leadership: traits, approaches situational, contingency, path goal approach, transactional and transformational leadership.	3
V	Group decision making: Reasons for using Committees and groups, successful operation of committees and groups, working in teams. Communication: purpose, process of communication, communication flow in the organization, barriers to communication, Improvement of communication; role of electronic media in communication.	5
	Controlling: Basic control process, feed forward and feedback control, performance measures and control, requirement of effective control, use of Information Technology for control.	3

TEXT BOOK		
1	Essentials of Managements an Introduction, Koontz, Tata McGraw-Hill, New Delhi.	2002
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub.**
1	Fundamentals of Managements, Robbins, Pearson Education	1995
2	Works Organisation and Management, Basu and Sahu, IBH	2005
3	Industrial Organisation and Management, Bethel, Atwater, Smith &Stachmax, McGraw Hill	2010
4	Principles of Industrial Organization, Kimbal and Kimbal, McGraw Hill	2008
5	Principles of Industrial Management, Leon Pratt Alford, Henry Russell Beatty, Revised Edition, Ronald Press Co.	2001
6	Works Organisation & Mgt, SK Basu, K. C. Sahu, N. K. Datta , Oxford & IBH.	1992
7	Management, Griffin, John Wiley and Sons.	2002
8	Management: Tasks, Responsibilities &Practices, Drucker P. F., Allied Pub.	1995
8	Raju, Industrial Engg and Management, Cengage learning	2015

Course outcome

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

CO1: Describe the basic concepts and theories related to scientific management.

CO2: Identify the need and scope of ownership and planning.

CO3: Discuss the need and scope of organising and staffing.

CO4: Apply various theories and techniques related to human factors for motivation.

CO5: Evaluate the communication needs ,barriers and constraint in an organisation and identify management control process and its implications.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1 PSO2
CO1	2	2	2			2			1			
CO2	1		2									
CO3			2						1	1		
CO4	2					1		1		1		
CO5	2	2	2	2	2							
Average	**1.8**	**2.0**	**2.0**	**2.0**	**2.0**	**1.5**		**1.0**	**1.0**	**1.0**		

4PIU11: PRODUCTION PRACTICE - II

B.Tech. (P&I) 4th semester
0L+0T +3P

UNIT	NAME OF EXPERIMENT
1	To study of single point cutting tool geometry and to grind the tool as per given tool geometry.
2	To study the milling machine, milling cutters, indexing heads and indexing methods and to prepare a gear on milling machine.
3	To machine a hexagonal / octagonal nut using indexing head on milling machine.
4	To cut BSW/Metric internal threads on lathe machine.
5	To cut multi-start Square/Metric threads on lathe machine.
	Boring using a boring bar in a centre lathe.
6	Study of capstan lathe and its tooling and prepare a tool layout & job as per given drawing.
7	Demonstration on milling machine for generation of plane surfaces and use of end milling cutters.
8	Grinding of milling cutters and drills.
9	Exercise on cylindrical and surface grinders to machine surfaces as per drawing.
10	Cylindrical grinding using grinding attachment in a centre lathe

Course outcome

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

CO1: Describe the geometry of single point cutting tool.

CO2: Explain milling machine , milling cutters , indexing head and prepare a job on milling machine .

CO3: Transform internal and external thread using lathe machine

CO4: Study capstan lathe and prepare job as per drawing

CO5: Practice of grinding of milling cutters and drills.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1
CO1	3	3	2	2								
CO2	3	3	2									
CO3	3	2		2								
CO4	3	3		2								
CO5	3	2				2						
Average	**3.0**	**2.6**	**2.0**	**2.0**		**2.0**						

4PIU12: PRODUCTION ENGINEERING DRAWING

B.Tech. (P&I) 4th Semester

0L+0T+3P

SN	CONTENTS
	Review of sectioning, Review of BIS Standard (SP 46), Fasteners – screws, bolts and nuts, riveted joints, pins, locking devices, welded joints, pipe joints, unions and valves. Assemblies involving machine elements like shafts, couplings, bearing, pulleys, gears, belts, brackets. Tool drawings including jigs and fixtures. Engine mechanisms-assembly and disassembly. Production drawings - limits, fits and tolerances, dimensional and geometric tolerances, surface finish symbols. Layout drawings. Schematics, process and instrumentation diagrams, piping drawings. Structural drawings - examples for reading and interpretation. Computer aided design and use of software packages for engineering drawings
	Assembly Drawing with sectioning and bill of materials Universal Coupling, Forming punch and die, Jigs for inspecting shaft etc.(1 drawing sheet of any assembly) Lathe tail stock, shaper tool head, steam stop valve, feed check-valve, swivel machine vice etc (1 drawing sheet of any assembly)
	Detailed part drawings from assembly drawing indicating fits, tolerances and surface finish symbols by referring BIS codes (1 drawing sheet) Check-valve, Junction Valve etc.
	Computer Aided Drafting (4 drawings) Introduction, input, output devices, introduction to software like AutoCAD/ProE/ Creo/Solidworks, basic commands and development of 2D and 3D drawings of simple parts
	Free Hand Sketches: Connecting rod, crank shaft, Pipes and Pipe fittings, machine arbor and cutter, universal dividing head, jigs and fixtures, Step less drive, sliding gear box, safety valve, three way stop valve, blow-off cock, Swivel bearing, Turret Tool Post, drill-press vice, screw jack
TEXT BOOK	
1	Laxminarayan and M.L. Mathur,Machine Drawing ,Jain Brothers
REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1	Gill P S, Machine Drawing, Kataria & Sons
2	Basudeb Bhattacharya, Machine Drawing, Oxford University Press
4	Ostrowsky, O., Engineering Drawing with CAD Applications, ELBS
5	Siddeshswar N., P Kannaiah, VVS Shastry, Machine Drawing,Tata McGraw Hill

Course outcome

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

CO1: Review BIS standards for drawing and mechanical components.

CO2: Construct assembly drawing of mechanical systems with bill of materials.

CO3: Interpret assembly drawings and prepare part drawings indicating fits,tolerances,surface finish

CO4: Produce freehand sketches or components,piping drawings

CO5: Develop 2-D and 3-D models on CAD software.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	
CO1	3		2									1
CO2									1			1
CO3									1			1
CO4									1			1
CO5					3				1			1
Average	**3.0**		**2.0**		**3.0**				**1.0**			**1.0**

4PIU13: THEORY OF MACHINES LAB.

B.Tech. (P&I) 4th Semester
0L+0T+2P

SN	NAME OF EXPERIMENT
1	To study inversions of four bar chain and slider crank mechanism and their practical applications.
2	To study Steering Mechanisms: Davis and Ackerman.
3	Study of quick return mechanism and its practical applications.
4	Study of inversion of Double slider chain: Oldham Coupling, Scotch Yoke and Elliptical Trammel.
6	Study of various cam-follower arrangements.To plot displacement v/s angle of rotation curve for various cams
7	To determine co-efficient of friction using two roller oscillating arrangement.
8	Study of various types of dynamometers, Brakes and Clutches.
9	Study of differential gear box.
13	To verify the torque relation for gyroscope.
16	To perform wheel balancing. To perform static and dynamic balancing on balancing set up.
19	Study of a lathe gear box, sliding mesh automobile gear box, planetary gear box.

Course outcome

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

CO1: to plot various performance curves of the machine elements

CO2: to perform different balancing operations

CO3: to determine the various operating parameters of oscillating machines

CO4: to study the gear operated systems

CO5:

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1
CO1	3	3	1	3								
CO2	3	3	1	2								
CO3	3	3	1	3								
CO4	3	1	1	2								
Average	**3.0**	**2.5**	**1.0**	**2.5**								

4PIU14: WORK SYSTEM DESIGN LAB

B.Tech. (P&I) 4th Semester	
0L+0T+2P	
SN	**LABORATORY WORK**
1	Rating: To obtain practice in rating operators' performance in Card Dealing and Walking.
2	Man Machine Chart a) Prepare man machine chart for drilling two holes in a plate 10 mm thick on a radial drilling machine. b) To determine standard time for drilling a hole in mild steel workpiece by stopwatch method.
3	Two handed Process Chart a) To draw two handed process chart for bulb holder assembly and to suggest a satisfactory layout. b) To find out standard time for assembly.
4	Left - Hand and Right - Hand Operation Chart a) To make left hand and right hand operation chart for bolts and washer assembly. b) Draw work place layout using principles of motion economy.
5	Pin Board Experiment
6	To practice various Graphic tools for method study
	To study with reference to the bulb holder assembly operation the following aspects : (i) Learning effect (ii) Sequence of operation (iii) Preparation of 2-H process chart and computing cycle time.
7	To determine the normal working area, max. working area, height for a normal man (i) for the assembly of pins in a box (ii) For the assembly of Nuts, bolts and washers.
8	Work sampling Practice
9	MTM practice
10	To study the operator's performance under different working conditions (light, temperature, sound, atmosphere etc.)

Course outcome

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

CO1: Practice the basic concepts of evaluation of operator's performence.

CO2: Apply various charts and diagrams to record micro and macro work elements of job.

CO3: Compute and correlate the human factors with work measurment.

CO4: Study various ergonomics parameters for work system design.

CO5:

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1	PSO2
CO1	1	2											
CO2		2	2										
CO3			3	1	2								
CO4				1									
Average	**1.0**	**2.0**	**2.5**	**1.0**	**2.0**								

4PIU20: DISCIPLINE AND EXTRA CURRICULAR ACTIVITIES

Course outcome

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

CO1: Recognize their strength and those of others to work towards a shared vision (leadership)

CO2: Develop and sustain healthy and meaningful relationship with others (Interpersonal skills)

CO3: Identify and address the needs of the community collaboratively to facilitate positive social change (Social Responsibility)

CO4: Generate innovations through experimentation with novel ideas, forms, and methods (Critical and creative thinking)

CO5: Act as a disciplined citizen with ethical and moral values

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1 PSO2
CO1						2	1	3	2	1		2
CO2						2	1	2	3	3		1
CO3						3	2	2	2	2		2
CO4	3	2	2	2	2		1		2	1		2
CO5						2	1	3	1	1		2
Average	**3.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.3**	**1.2**	**2.5**	**2.0**	**1.6**		**1.8**

5PIU1: THERMAL ENGINEERING

B.Tech. (P&IE) 5th semester
3L+1T

Unit	Contents	Contact hours
I	**Heat Transfer**: Introduction, Fourier's law of conduction, Newton Rikhman equation, Stefan Boltzmann law, Overall heat transfer coefficient.	2
	Conduction: Three dimensional heat flow equation-Cartesian coordinates. One dimensional steady state conduction without heat generation, One dimensional flow through a plane wall, composite wall and tube, thick spherical shell, Critical insulation, Heat flow through fins.	6
II	**Convection**: Dimensional analysis of forced and free convection, empirical relations.	5
	Radiation: Introduction, Absorption, reflection and transmission, Monochromatic, total emissive power, view factor	3
III	**Heat exchanger**: Types of Heat Exchanger, LMTD equation for parallel and counter flow Heat Exchanger and its applications. Effectiveness - NTU Method	8
IV	**Refrigeration:** Air refrigeration system, vapour compression and vapour absorption system, steam refrigeration	4
	Refrigerants, Refrigeration equipments, Reciprocating Air Compressor.	4
V	**Air Conditioning**: Properties of moist air, Psychrometric chart and its use, Elementary psychrometric processes. Comfort Air Conditioning.	8
	TOTAL	40

TEXT BOOK		
1	J.P. Halman, Heat Transfer, Mc Graw Hill	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Incropera and Dewitt, Fundamental of Heat and Mass transfer, J. Wiley	2007
2	Cengel, Heat and Mass transfer, Mc Graw Hill	2011
3	M.Thirumaleshwar, Fundamental of Heat and Mass Transfer, Pearson Ed.	2006
4	Ozisik, Heat and Mass Transfer, Mc Graw Hill	2009
5	C.P. Arora, Refrigeration and Air Conditioning, Tata McGraw Hill.	2008

Course outcome

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

CO1: Describe various modes of heat transfer. Analyze heat conduction equation in Cartesian coordinates. And apply principles of heat flow through fins

CO2: Explain dimensional analysis of forced and free convection. Illustrate concepts of radiation.

CO3: Analyze the performance of heat exchangers

CO4: Describe various refrigeration systems, refrigerants and equipments.

CO5: Explain Properties of moist air, Psychrometric chart and its use, Elementary psychrometric processes and comfort Air Conditioning

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1 PSO2
CO1	3	3	1									1
CO2	3	3	2	2								2
CO3	3	3	2	3			2					2
CO4	3	3	2	2			2					1
CO5	3	3	2	2			2					1
Average	**3.0**	**3.0**	**1.8**	**2.3**			**2.0**					**1.4**

5PIU2: DESIGN OF MACHINE ELEMENTS- II

B.Tech. (P& I) 5th Semester
3L+1T

Unit	Contents	Contact hours
I	**Fatigue Considerations in Design:** Variable load, loading pattern, endurance stresses, Influence of size, surface finish, notch sensitivity and stress concentration.	3
	Goodman line, Soderberg line, Design of machine members subjected to combined, steady and alternating stresses.	3
	Design for finite life, Design of Shafts under Variable Stresses, Bolts subjected to variable stresses.	2
II	**Design of IC Engine components:** Piston, Cylinder, Connecting Rod and Crank Shaft.	8
III	Design of helical compression, tension, torsional springs, springs under variable stresses.	4
	Design of belt, rope and pulley drive system,	4
IV	**Design of gear teeth:** Lewis and Buckingham equations, wear and dynamic load considerations.	4
	Design and force analysis of spur, helical, bevel and worm gears, Bearing reactions due to gear tooth forces.	4
V	**Design of Sliding and Journal Bearing:** Methods of lubrication, hydrodynamic, hydrostatic, boundary etc. Minimum film thickness and thermal equilibrium.	4
	Selection of anti-friction bearings for different loads and load cycles, Mounting of the bearings, Method of lubrication.	4
	TOTAL	40

TEXT BOOK		
1	Design of Machine Elements, Bhandari V.B, 3rd Ed., Tata McGraw-Hill, New Delhi	2010
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Machine Design, Sharma and Aggarwal, Kataria and Sons, Delhi.	1997
2	Mechanical Engg Design, Shigley, Mischke, Budynas and Nisbett, Tata McGraw-Hill	2002
3	PSG Design Data Book, P.S.G. College of Technology, Coimbatore.	1966
4	A Text Book of Machine Design, Karwa A., Laxmi Publication.	2002
5	Machine Design, Hall, Holwenko and Laughlin, Schaum's Outlines Series, Tata McGraw Hill.	

Course outcome

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

CO1: Predict the failure of machine component under fatigue loading conditions and design the components for finite and infinite life.

CO2: Analyse and design IC Engine components, springs, belt and pulley drives.

CO3: Assess and evaluate the forces on gear teeth of spur , helical worm gears and calculate gear size.

CO4: Evaluate the performance of journal bearings and manipulate the parameters according to operating conditions.

CO5: Select the suitable rolling contact bearing for different load conditions

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1	PSO2
CO1	2	3	2	1									
CO2	2	3	2	1									
CO3	2	3	3	1									
CO4	2	3	2	1									
CO5	2	3	1	1									
Average	**2.0**	**3.0**	**2.0**	**1.0**									

5PIU3: QUALITY CONTROL AND RELIABILITY ENGINEERING

B.Tech. (P&IE) 5th semester

3L+0T

Unit	Contents	Contact hours
I	The meaning of Quality and quality improvement, dimensions of quality, history of quality methodology, quality control, Quality of design and quality of conformance, Quality policy and objectives, Economics of quality.	5
	Modeling process quality: Describing variation, frequency distribution, continuous and discrete, probability distributions, pattern of variation, Inferences about process quality: sampling distributions and estimation of process parameters. Analysis of variance.	4
II	Statistical Quality Control: Concept of SQC, Chance and assignable causes of variation, statistical basis of control chart, basic principles, choice of control limits, sample size and sampling frequency, analysis of patterns on control charts. The magnificent seven.	4
	Control chart for variables,: X-bar and R charts, X-bar and S charts, control chart for individual measurement. Application of variable control charts.	4
III	Control chart for attributes: control chart for fraction non conforming P-chart, np-chart, c-chart and u-chart. Demerit systems, choice between attribute and variable control chart. SPC for short production runs. Process capability analysis using histogram and probability plot, capability ratios and concept of six sigma.	7
IV	Quality Assurance: Concept, advantages, field complaints, quality rating, quality audit.	2
	Acceptance Sampling: Fundamental concepts in acceptance sampling, operating characteristics curve. Acceptance sampling plans, single, double and multiple sampling plans, LTPD, AOQL, AOQ.	4
	Introduction to Quality systems like ISO 9000 and ISO 14000.	2
V	Reliability and Life Testing- Failure models of components, definition of reliability, MTBF, Failure rate, common failure rate curve, types of failure, reliability evaluation in simple cases of exponential failures in series, paralleled and series-parallel device configurations, Redundancy and improvement factors evaluations. Introduction to Availability and Maintainability	8
	TOTAL	**40**

TEXT BOOK		
1	Introduction to Statistical Quality Control, Douglas C. Montgomery, 2nd Edition, Wiley.	1991
2	Charles E. Ebeling, An introduction to reliability and maintainability engineering, Tata McGraw-Hill Education.	2004
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Quality Planning and Analysis, J.M.Juran and F.M. Gryna, McGraw Hill	2002
2	Quality Control, Dale H. Besterfield, 8th Edition, Pearson/Prentice Hall	2008
3	Statistical Quality Control, E. L. Grant and Richard S. Leavenworth, TMH	2000
4	Fundamentals of Quality Control and Improvement, Amitava Mitra, 2nd Edition, Prentice Hall	1998

Course outcome

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

CO1: Discuss the fundamental of quality and various probablity distribution.

CO2: practice various tools and techniques of SQC.

CO3: Construct various control charts and analyse process capability

CO4: Identify quality assurance and implement acceptance sampling.

CO5: Experimental work using DOE and taguchi.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1 PSO2
CO1	3	2		3	2							1
CO2	3	2	1	2	2	1						2
CO3	3	2	2	3	1							1
CO4	3	2	1	3	1	2						1
CO5	2	2	2	3	2							2
Average	**2.8**	**2.0**	**1.5**	**2.8**	**1.6**	**1.5**						**1.4**

5PIU4: MEASUREMENT & METROLOGY

B.Tech. (P&IE) 5th semester
3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	**Concept of measurement:** General concept of measurement, Need for measurement, Generalized measuring system, Units, Standards, Sensitivity, Readability, Range of accuracy, Precision, Accuracy Vs precision, Uncertainty.	4
	Repeatability and reproducibility, Errors in measurement, Types of error, Systematic and random error, Calibration, Interchangeability.	3
II	**Linear and angular measurements:** Linear measuring instruments: Vernier caliper, Micrometer, Slip gauges, Optical flat, Application of limit gauges;	3
	Comparators:- Mechanical comparators, Electrical comparator, Pneumatic comparator;	2
	Sine bar, Use of sine bar, Limitations of sine bars, Sources of error in sine bars, Bevel protractor, Applications of bevel protractor.	4
III	**Form measurement:** Introduction, Screw thread measurement, Thread gauges, Measurement of gears: Gear errors, Spur gear measurement, Parkinson gear tester.	4
	Surface finish measurement:-Introduction, Elements of surface texture, Analysis of surface finish, Methods of measuring surface finish, Straightness measurement, Flatness testing, Roundness measurements	4
IV	**Machine tool metrology**:Coordinate measuring machine (CMM):-Types of CMM, Features of CMM,Computer based inspection, Computer aided inspection using robots.	5
V	**Measurement of force**: Accelerometer, Load cells. **Torque measurement:** Torque measurement using strain gauges, Torque measurement using torsion bars, **Measurement of power**: Mechanical dynamometers,	4
	Measurement of flow: Variable area meters – rotameter, Hot wire anemometer, Pitot tube. **Temperature measurement**: Thermocouples (Thermo electric effects), Thermistors, Pyrometers	4
	TOTAL	40

TEXT BOOK		
1	G.K. Vijayaraghavan & R. Rajappan, Engineering Metrology and Measurements, A.R.S. Publications, Chennai, Fourth Edition June	2009
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Mechanical Measurements , Beckwith T.G. ,N.L. Buck, and R.D. Marangoni , Addison Wesley	
2	Dimensional Metrology . Khare & Vajpayee, Oxford & IBH	
3	Engineering Metrology, Jain R.K., Khanna Publishers	
4	Metrology & Precision Engineering , Scarr, McGraw Hill	
5	Handbook of Industrial Metrology, ASTME	

Course outcome

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

CO1: Describe the basic concepts of measurement & measuring system.

CO2: Learn the various types of measuring instruments & their uses.

CO3: Identify & classify the measurement process for a particular application.

CO4: Apply the concepts for measuring the properties of the system.

CO5: Illustrate the measurement such as power, torque flow and temperature.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1	PSO2
CO1	3		3										
CO2	3	3	3	2									
CO3	3	3	3	2									
CO4	3	3	3	2									
CO5	3	3		2	1								
Average	**3.0**	**3.0**	**3.0**	**2.0**	**1.0**								

5PIU5.1: PRINCIPLES OF MACHINE TOOLS

B.Tech. (P&IE) 5th semester

3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	Machine tools:- Concept and definition of machining and machine tools. Concept of producing geometrical surfaces by generatrix and directrix.	5
	Type of Machine tools, General requirements of machine tool design, Workinng and auxiliary motions in machine tools, Parameter defining working motion of machine tool.	3
II	Machine drives: Mechanical transmission, Hydraulic transmission, Electrical circuits.	2
	Stepped regulation of speed: Design of speed box. Design of machine tool structures, Basic principles of design for strength, Basic principles of design for rigidity.	2
	Introduction to design of lathe beds	4
III	Introduction to guides and slideways: Types of slideways, Design of slideways, Shapes of slideways, Application of slideway Profiles and their combination, Material of slideways, Type of connecting sections and their applications, Clearance adjustment in slides. Anti-friction guideways.	8

IV	Machine tool spindles and spindle bearings, Kinematic systems and operations of lathes, Kinematic systems and operations of drilling machine, Kinematic systems and operations of milling machine.	**8**
V	Construction, working principle and applications of shaping, planing and slotting machines	**4**
	Alignment & Acceptance test of lathe, milling, drilling machines	**4**
	TOTAL	**40**

TEXT BOOK		
1 **2**	Machine tool design by N K Mehta Principle of machine tools by G C Sen & Bhattacharya	**2007**
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Rao.P.N., Manufacturing Technology, Vol. 1,2 and 3, Tata McGraw Hill	**2013**
2	Ghosh, A., & Mallik, A. K.. Manufacturing Science: East West Press Private Limited.	**1986**
3	Schey, Introduction to Manufacturing Processes, Tata McGraw Hill	**2000**
4	Kalpakjian, S., & Schmid, S. R., Manufacturing processes for engineering materials, Pearson Education.	**2008**
5	Pandey & Singh, Production Engineering Science, Standard Publishers Distributer, Delhi.	**1999**
6	Stephenson, D. A., & Agapiou, J. S. Metal cutting theory and practice: CRC Taylor & Francis.	**2006**
7	Karl H.Heller, All About Machine Tools, Wiley Eastern Ltd., New Delhi	**1972**
8	Kalpakjian, S. & Schmid S.R, Manufacturing Engineering and Technology, Addison Wesley Pub. Co.	**2000**
9	Sen, G. C., & Bhattacharyya, A. Principles of Machine Tools: New Central Book Agency	**1988**
10	Bhattacharyya A, Theory & Practice of Metal Cutting, New Central Book Agency	**2006**
11	Shan, H.S., Manufacturing Process, Pearson Education.	**2012**
12	Boothroyd, G., & Knight, W. A. Fundamentals of machining and machine tools: Taylor and Francis.	**2006**
13	Milton C. Shaw, Metal Cutting Principles, CBS Publishers.	**2005**
14	Trent, E. M. Metal cutting: Butterworth Heinemann	**2000**

5PIU5.2: RENEWABLE ENERGY SYSTEMS

B.Tech. (P&I) 5th semester
3L+1T

Unit	CONTENTS	Contact Hours
I	Global and National scenarios, Form and characteristics of renewable energy sources. **Solar Energy:** Solar radiation, its measurements and prediction, Solar thermal collectors, flat plate collectors, concentrating collectors, Basic theory of flat plate collectors, solar heating of buildings, solar still, solar water heaters, solar driers, conversion of heat energy in to mechanical energy, solar thermal power generation systems.	2
	Solar Photovoltaic: Principle of photovoltaic conversion of solar energy, types of solar cells and fabrication, **Photovoltaic applications:** battery charger, domestic lighting, street lighting, water pumping, power generation schemes	3
II	**Wind Energy:** Atmospheric circulations, classification, factors influencing wind, wind shear, turbulence, wind speed monitoring, Betz limit, WECS-classification, characteristics, applications.	3
III	**Ocean Energy:** Ocean energy resources, ocean energy routes, Principles of ocean thermal energy conversion systems, ocean thermal power plants, Principles of ocean wave energy conversion and tidal energy conversion.	4
IV	**Other Sources:** Nuclear fission and fusion, Geothermal energy- Origin, types of geothermal energy sites, site selection, geothermal power plants, Magneto-hydro-dynamic (MHD) energy conversion, Formation of biomass, photosynthesis, Biomass resources and their classification, Chemical constituents and physicochemical characteristics of biomass, Biomass conversion processes.	5
V	**Fuel Cells:** Thermodynamics and electrochemical principles, Basic design, types, applications. **Hydrogen Energy:** Economics of hydrogen, Production methods.	5
	TOTAL	**40**

TEXT BOOK		**Ed.**
1	Power Generation through Renewable Source of Energy, Rai and Ram Prasad, Tata McGraw-Hill, New Delhi.	2004
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub Year .**
2	Renewable Energy Sources and Conversion Technology, Bansal, Kleemann and Meliss, TMH	2013
3	Solar Energy: Fundamental and Applications, H. P. Garg J Prakash, TataMcGraw-Hill	2006
4	Solar Energy: Principles of Thermal Collection and Storage, S P Sukhatme, TMH	1994

CO 1	To understand the various renewable systems											
CO 2	To learn the various sources of renewable energy											
CO 3	To examine the operating conditions of systems											
CO 4	To explore the systems and apply for various purposes											
Course	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12

Outcomes												
C01	3	3	2	1	-	-	-	-	-	-	-	-
C02	3	2	1	2	-	-	-	-	-	-	-	-
C03	3	3	2	1	-	-	-	-	-	-	-	-
C04	3	3	1	2	-	-	-	-	-	-	-	-
CO5	3	2	3	2	-	-	-	-	-	-	-	-

5PIU5.3: ADVANCED WELDING TECHNOLOGY

B.Tech. (P&I) 5th semester
3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	**Welding:** Introduction, Classification, Advantages and disadvantages of welding and Selection of power sources: Constant voltage and constant current power sources. Heat Transfer and associated losses. Metal Transfer:Mechanism and types of metal transfer in various arc welding processes.	**8**
II	**Solid state welding:** Classification of solid state welding processes, advantages, and applications. Ultrasonic welding Process and Explosive Welding.	**7**
III	**Friction welding:** Friction welding process variables, welding of similar and dissimilar materials, Defective analysis of friction welded components, Friction welding of materials with inter layer. Friction stir welding: Processes parameters, tool geometry, welding of similar and dissimilar materials, Friction stir welding of Aluminum alloys and Magnesium alloys. Introduction of Hybrid FSW.	**8**
IV	**EBW and LBW:** Electron Beam welding process parameters, atmospheric affect Defective analysis of Electron beam welds and Electron Beam welding dissimilar materials. Laser Beam welding process parameters, atmospheric affects in LBM and Laser Beam welding of steels.	**8**
V	**Weldability:** Weldability studies of cast iron and steel, Effects of alloying elements on weld ability, welding of plain carbon steel, Cast Iron and Aluminum. Micro & Macro structures in welding. Welding defects and inspection methods.	**7**
	TOTAL	**40**

TEXT BOOK		
1	Nadkarni S.V., *Modern Welding Technology*, Oxford IBH Publishers, 1996.	**2009**
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	D. L. Olson, T. A. Siewert, *Metal Hand Book, Vol 06, Welding, Brazing and Soldering*, ASM International Hand book Metals Park, Ohio USA, 2008.	**2012**
2	Howard B. Cary , Scott Helzer, Modern Welding Technology Paperback , Pearson Edu.	**2004**
3	K. S. Yadav, Advanced Welding Technology, Standard Book House	**2018**

5PIU6.1: CNC MACHINES AND PROGRAMMING

B.Tech. (P&IE) 5th semester
2L+0T

UNIT	CONTENTS	CONTACT HOURS
I	Introduction: Definition of NC, Applications of NC ,Historical Developments in Automation,Classification of NC Systems,Comparison of NC and Conventional Machines,Advantages of NC	**8**
II	NC Hardware: Architecture of NC Systems, Design Considerations, Mechanical Elements, Structure, Guideways and Slides, Guideway Elements, Transmission Systems, Spindle Unit, Coolant system, Lubrication System, Tool and work Changing Mechanisms, Electrical Elements, Drives, Sensors, Control Loops, Computing Elements/ Firmware, Interpolators	**8**
III	NC Software: Introduction, Manual Part Programming, Computer-Assisted Part Programming, Language Based , Geometric Modeling Based, Automatic Part Program Generation,	**8**
IV	CAPP Systems, 5 Axis Programming, Post-Processing, Programming Robots and CMMs	**4**
	NC Simulation, Kinematic simulation, Volumetric simulation, Applications of Volumetric NC Simulation, Verification	**4**
V	Advanced Topics:, Adaptive Control, Off-line adaptive control, Various optimisation criteria, Hardware Based AC, Software Based AC, Tooling and Instruments for NC Special Considerations in High Speed Cutting (HSC) and Die Sinking, Rapid Product Development, CAM, FMS, CIM	**8**
	TOTAL	**40**

TEXT BOOK		
1	Krar S. and Gill A., CNC: Technology and Programming, McGraw Hill	1990
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Koren Y., Computer Control of Manufacturing Systems, Tata McGraw Hill.	1983
2	Pressman R.S. and Williams J.E., Numerical Control and Computer-Aided Manufacturing, John Wiley & Sons	1977,
3	Jones B.L.,Introduction to Computer Numerical Control, John Wiley & Sons.	1986
4	Kral I.H., , Numerical Control Programming in APT, Prentice-Hall	1986
5	Chang C.H. and Melkanoff M.A., ,NC Machine Programming and Software Design, Prentice-Hall	1986

Course outcome

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

CO1: Implementation and Examine applications and advantages of CNC machines and technology.

CO2: Recognize about the CNC machine tool Structure.

CO3: Knowledge of basic programming codes and calculation of CNC Machining Parameters.

CO4: Preparation of CNC program for CNC Lathe & Milling

CO5: Demonstrate and verify NC softwareβ€™s, Sensors, NC modeling & Simulation and Robotics.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1 PSO2
CO1	3	1										
CO2	3	1		2						2		
CO3	3	3	2	3						2		
CO4	3	3	3	3						2		
CO5	3	3	3	3						2		
Average	**3.0**	**2.2**	**2.7**	**2.8**						**2.0**		

5PIU6.2: MANAGEMENT INFORMATION SYSTEM

B.Tech. (P&I) 5th semester
2L+0T

UNIT	CONTENTS	CONTACT HOURS
I	Organisation & Types, Decision Making, Data & information, Characteristics & Classification of information,	3
	Cost & value of information, Various channels of information & MIS.	2
II	Foundation of Information System : Introduction to Information System in Business Fundamentals of Information System, Solving Business Problems with Information System,	4
	Concept of Balanced MIS, Effectiveness & Efficiency Criteria. Tool and Techniques of MIS- dataflow diagram, flow chart etc.	4
III	Business application of information technology, electronic commerce, Internet, Intranet, Extranet & Enterprise Solutions, Information System for Business Operations,	5
	Information system for managerial Decision Support, Information System for Strategic Advantage	5
IV	Managing Information Technology, Enterprise & Global Management, Security & Ethical Challenges, Planning & Implementing Change..	4
	Reports: Various types of MIS reports, GUI & Other Presentation tools	4
V	Advanced concepts in information system: Enterprise Resource Planning: introduction, various modules like Human Resources, Finance, Accounting, Production & Logistics.	5
	Supply Chain Management, CRM, Procurement Management System Object Oriented modeling case studies.	4
	TOTAL	**40**

TEXT BOOK		
1	Information systems for Modern Management, G.R.Murdick, Prentice Hall of India	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Management Information systems, S.Sadagopan, Prentice Hall of India	
2	Management Information Systems, Effy Oz, Cengage Learning	
3	Management Information Systems, James A O Brien, Irwin McGraw Hill	
4	Management Information Systems, Laudon and Laudon, Prentice Hall of India	

5PIU6.3: STATISTICS FOR DECISION MAKING

B.Tech. (P&IE) 5th semester

2L+0T

Unit	Contents	Contact Hours
I	Introduction - Statistical Terminology: Descriptive statistics or exploratory data analysis, inferential statistics, population, sample, variable, parameter, statistic, random sample.	3
	Collecting Data: Historical data, types of studies (comparative, descriptive or noncomparative, observational, experimental),sample surveys, sampling and nonsampling errors, bias, representative sample, judgment sampling, quota sampling, simple random samples, sampling rate, sampling frame, stratified random sampling, multistage cluster sampling, probability-proportional-to-size sampling, systematic sampling.	4
II	Summarizing and Exploring Data: Variable types (categorical, qualitative, nominal, ordinal, numerical, continuous, discrete, interval, ratio), summarizing categorical data (frequency table, bar chart, Pareto chart, pie chart), summarizing numerical data (mean, median), skewness, outliers, measures of dispersion (quantiles, range, variance, standard deviation, interquartile range, coefficient of variation) standardized z-scores, histogram, bivariate numerical data (scatter plot, simple correlation coefficient, sample covariance), straight line regression, summarizing time-series data, data smoothing, forecasting techniques.	4
	Basic Concepts of Inference: Estimation, hypothesis testing, point estimation, confidence interval estimation, estimator, estimate, bias and variance of estimator, mean square error, precision and standard error, confidence level and limits, null and alternative hypothesis, type I and II error, probabilities of type I and II error, acceptance sampling, simple and composite hypothesis, P-value, one-sided and two -sided tests.	4
III	Inference for Single Samples: Inference for the mean (large samples), confidence intervals for the mean, test for the mean, sample size determination for the z-interval, one-sided and two -sided z-test, inference for the mean (small samples), t distribution.	4
	Inference for Two Samples: Independent sample design, matched pair design, pros and cons of each design, side by side box plots, comparing means of two populations, large sample confidence interval for the difference of two means, large sample test of hypothesis for the difference of two means, inference for small samples (confidence intervals and tests of hypothesis).	4
IV	Inference for Proportions and Count Data: Large sample confidence interval for proportion, sample size determination for a confidence interval for proportion,	3
	Large sample hypothesis test on proportion, comparing two proportions in the independent sample design (confidence interval and test of hypothesis), chi-square statistic	4
V	Simple Linear Regression and Correlation: Dependent and independent variables, probability model for simple linear regression, least squares fit, goodness of fit of the LS line, sums of squares, analysis of variance, prediction of future observation, confidence and prediction intervals,	4
	Multiple Linear Regression: Probability model for multiple linear regression, least squares fit, sums of squares.Use Excel, R, and MATLAB® in the class.	4
	TOTAL	**40**

TEXT BOOK		
1	Ajit Tamhane and Dorothy Dunlop "Statistics and Data Analysis: From Elementary to Intermediate" Prentice Hall	1999
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub.**
1	Richard Levin, David S. Rubin, Statistics for Managements, PHI	1988
2	J. K. Sharma, Statistics for Management, Pearson Education India	2001

5PIU11: THERMAL ENGINEERING LAB

B.Tech. (P&IE) 5th Semester
0L+0T+3P

SN	NAME OF EXPERIMENT
1	Comparative study of a) Four stroke diesel and petrol engines. b) Two stroke petrol and diesel engines
2	Studies of fuel supply systems of diesel and petrol engines.
3	Study of cooling, lubrication and ignition system in diesel and petrol engines.
4	To study various types of Boilers and to study Boiler mounting and accessories.
5	To study various types of Dynamometers.
6	To study Multi Stage Air Compressors.
7	To find the BHP, Thermal efficiency of four stroke diesel engine.
8	Study of Brakes, Clutches, and Transmission System.
9	To prepare a comparison sheet of various automobiles (4 Wheeler and 2 Wheeler).
10	Study of parallel flow and counter flow heat exchanger.
11	Load test on Petrol Engine and Diesel engine.
12	Determination of conductivity of insulating powder.
13	Determination of effectiveness of parallel and counter flow heat exchanger.

Course outcome

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

CO1: categorizing and demonstrating various engines and systems involved in automobiles

CO2: comparing the working of various boilers and their mountings

CO3: determine different parameters used in IC engines

CO4: discuss and identify the flow arrangements used in heat exchanger

CO5: evaluate the performance parameters of heat exchanger

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1
	PSO1	PSO2										
CO1	2	1	1	2					2			2
CO2	2	2	2	2		1			1			2
CO3	1	3	2	2	1	1			2			1
CO4	2	2	2	2	1				1			2
CO5	1	3	2	2					2			1
Average	**1.6**	**2.2**	**1.8**	**2.0**	**1.0**	**1.0**			**1.6**			**1.6**

5PIU12: MACHINE TOOL DESIGN SESSIONAL

B.Tech. (P&I) 5th Semester **Max. Marks: 75**
0L+0T+2P **Exam Hours: 3**

SN	SESSIONAL WORK
1	Functional requirements of machine tools.
2	Working and auxiliary motions in machine tools.
3	Design criterion for machine tool structure, Static & dynamic stiffness.
4	Function & important requirements of spindle unit.
5	Importance of machine tool compliance with respect to machine tool accuracy.
6	Application and sketching of Slider-crank mechanism, Cam mechanism, Rack &

	pinion mechanism, Nut & screw mechanism, Ratchet gear mechanism, Geneva mechanism, Reversing mechanism, Differential mechanism, Norton mechanism, Mender's mechanism.
7	Aim of speed & feed rate regulation, stepped regulation of speed.
8	G.P. series is used in steeped regulation of speed.
9	Design a four / six speed Gear Box.
10	Design of Lathe bed. (including Torque analysis of lathe bed, bending of lathe bed, designing for torsional rigidity, use of reinforcing stiffener in lathe bed)
11	Analysis of force under headstock, tail stock and saddle.
12	Design of Guide ways / Slide ways.
13	Estimation of power requirements and selection of motor for metal cutting machine tool spindles.

5PIU13: METROLOGY LAB.

B.Tech. (P&IE) 5th Semester
0L+0T+2P

SN	NAME OF EXPERIMENT
1	Study of various measuring tools like dial gauge, micrometer, vernier caliper and telescopic gauges.
2	Measurement of angle and width of a V-groove by using bevel protector..
3	To measure a gap by using slip gauges
4	Measurement of angle by using sine bar.
5	Study and use of surface roughness instrument (Taylor Hobson make) Inspection of various elements of screw thread by Tool makers microscope and optical projector.
6	Measurement of gear tooth thickness by using gear tooth vernier caliper.
7	To check accuracy of gear profile with the help of profile projector.
8	To determine the effective diameter of external thread by using three-wire method.
9	To measure flatness and surface defects in the given test piece with the help of monochromatic check light and optical flat.
10	To plot the composite errors of a given set of gears using composite gear tester.
11	Measurement of coating thickness on electroplated part and paint coating on steel and non-ferrous material using coating thickness gauge.
12	Study and use of hardness tester for rubber and plastics.
13	To check the accuracy of a ground, machined and lapped surface - (a) Flat surface (b) Cylindrical surface.
14	To compare & access the method of small-bore measurement with the aid of spheres.

Course outcome

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

CO1: To define the concept of metrology and measuring instruments.

CO2: Classify and know the uses of measuring instruments

CO3: To observe and interpret the use of slip gause to build required dimension.

CO4: To measure the angle by using sine bar and bevel protector and use of combination set.

CO5: Demonstrate and use of profile projector to check dimensions.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1	PSO2
CO1	3	2	1		3								
CO2	3	3		1	3								
CO3	3	2		1	2								
CO4	3	3			2								
CO5	3				3								
Average	**3.0**	**2.5**	**1.0**	**1.0**	**2.6**								

5PIU14: QUALITY CONTROL LAB

B.Tech. (P&IE) 5th Semester
0L+0T+2P

SN	NAME OF EXPERIMENT
1	Case study on X bar charts and process capability analysis
2	PChart: (a)Verify the Binomial Distribution of the number of defective balls by treating the balls with a red colour to be defective. (b) Plot a P-chart by taking a sample of n=20 and establish control limits
3	To plot C-chart using given experimental setup
4	Operating Characteristics Curve: (a) Plot the operating characteristics curve for single sampling attribute plan for n = 20 ; c = 1 , 2 , 3 Designate the red ball to defective. (b) Compare the actual O.C. curve with theoretical O.C. curve using approximation for the nature of distribution
5	Distribution Verification: (a) Verification of Normal Distribution. (b) To find the distribution of numbered cardboard chips by random drawing one at a time with replacement. Make 25 subgroups in size 5 and 10 find the type of distribution of sample average in each case. Comment on your observations
6	Verification of Poisson distribution
7	Central Limit Theorem: (a) To show that a sample means for a normal universe follow a normal distribution. (b) To show that the sample means for a non normal universe also follow a normal Distribution.

6PIU1: TOOL ENGINEERING

B.Tech. (P&I) 6th semester
3L+1T

UNIT	CONTENTS	CONTACT HOURS
I	Introduction, properties of tool material, types of tool material,	5
	basic requirement of tool material and general consideration in tool design.	3
II	Design of material-cutting tool: Single point tools, basic principles of multiple point tools, Linear-Travel tools (Broach),	4
	Axial Feed Rotary Tools (Drill), Milling Cutters.	3
III	Introduction to press, Press accessories, Die design fundamentals, Strip layout,	4
	Blanking and piercing Dies, Combination Dies (compound & progressive die).	4
IV	Design of Bending Dies,	3
	Design of Drawing and Deep drawing dies.	5
V	Introduction to Jig & Fixtures, usefulness, Principles of Jig & Fixtures design, Principle of location, Locating and Clamping devices.	4
	Basic construction principle, Drilling jigs, Brief introduction about Milling fixtures, Grinding fixtures, Broaching and Lathe fixtures.	5
	TOTAL	**40**

TEXT BOOK		
1	Rao, P.N. "Manufacturing Technology" vol.I, Tata McGraw Hill Ltd	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Tool design by Donldson	**2009**
2	Tool design by ASTME	**2004**
3	Metal Cutting Theory and Cutting Tool Design, Arshinov & Acherken, MTR Publishers	**2001**
4	Machine Tool Design, Acherken, MIR Publishers	**1992**
5	Principles of Machine Tools, Sen & Bhattacharya, New Central Book Agency	**2001**
6	Principles of Metal Cutting, Shaw,M.C., Oxford & IBH	**1991**
7	Fundamentals of Tool Engineering Design, Basu, Mukhopadhyay & Mishra, Oxford & IBH	**1996**

Course outcome

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

CO1: Learn about materials properties of tool.

CO2: Evaluate different types of cutting tools

CO3: Describe the principles of Jig and fixtures.

CO4: Design of various dies used in manufacturing.

CO5: Review Press and Press working practices

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1	PSO1	PSO2
CO1	3													1

CO2	3	3	2	2		1	1
CO3	3	3				1	1
CO4	3	2	2	2		1	1
CO5	3	2		1		1	1
Average	**3.0**	**2.5**	**2.0**	**1.7**		**1.0**	**1.0**

6PIU2: FACILITIES PLANNING

B.Tech. (P&I) 6th Semester
3L+1T

UNIT	CONTENTS	CONTACT HOURS
I	Definition of facilities planning, significance and objectives of facilities planning. Process of facilities planning. Strategic facilities planning.	5
	Product selection, Review of various types of manufacturing processes and Process selection.	3
II	Facility Location: Need for location decisions, location factors, location analysis: Qualitative methods: subjective, equal weight, variable weight, factor point rating and composite measure method.	4
	Quantitative methods: location breakeven analysis, median model, gravity model, Brown and Gibson method, single facility location models, minmax location problem, Location allocation models, Bridgeman's Dimensional Analysis.	4
III	Facility Layout: Importance and function, objectives and advantages of good layout, types of plant layout problems. Basic layout types: Product, Process, Group and fixed position layout. Plant layout factors, Layout procedure, Systematic layout planning procedure, Flow and activity analysis, Process charts, flow diagram, Travel chart, activity relationship chart, and Relationship diagram. Evaluation and implementation of layout. Industrial buildings, influence of building on layout.	4
	Computer aided layout: CRAFT, CORELAP, COFAD, ALDEP, PLANET.	4
IV	Production and assembly line balancing - various operational research techniques for balancing of assembly line and fabrication line.	5
	Material Handling: Principles of material handling, materials handling system design. Systematic handling analysis, Unit loads. Computer Aided Material Handling.	3
V	Material Handling Equipment: Conveyors, monorail, hoists and Cranes; automated storage and retrieval systems (AS/RS) , Industrial trucks, Containers and supports, Auxiliary and other equipments	5
	Receiving and shipping, storage and warehousing; Equipment planning, layout planning.	3
	TOTAL	**40**

TEXT BOOK		
1	Facilities Planning, Tomphins James A & White John A, John Wiley & Sons	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Facility Layout & Location, Francis R.C. & White J.A. Prentice Hall.	**2002**
2	Material Handling, Immer, McGraw Hill	**2009**
3	Practical Plant Layout, Muther , McGraw Hill	**1998**
4	Plant Layout & Design , Immer , McGraw Hill	**2004**

Course outcome

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

CO1: Explain the objectives of facilities planning and compare various types of manufacturing processes

CO2: Classify location factors and relate quantitative factors for decision making in location planning

CO3: Explain various layout types and construct plant layout using systematic layout planning

CO4: Apply computer aided layout techniques.

CO5: Solve line balancing problems using operations research techniques.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1
	PSO1	PSO2										
CO1	3	2	1									
CO2	2	3	2	3	3							
CO3	3	2	2	3	2				2	3		
CO4	2	3	2	2	3							
CO5	2	2	3	1	2							
Average	**2.4**	**2.4**	**2.0**	**2.3**	**2.5**				**2.0**	**3.0**		

6PIU3: TOTAL QUALITY MANAGEMENT

B.Tech. (P&I) 6th semester
3L+0T

Unit	Contents	Contact Hours
I	Introduction to TQM: Definition, Basic approach, Guru's of TQM, TQM framework, benefits.	2
	Leadership: Characteristics of Quality Leadership, Leadership Concepts, The 7 Habits of Highly Effective People, The Deming Philosophy, The Role of TQM LeadersStrategic Planning Communications, Decision Making.	3
	Customer Satisfaction: Introduction, Customer Perception of Quality, Service Quality, Translating Needs into Requirements, Customer Retention.	3
II	Continuous Process Improvement: Introduction, Process, The Juran Trilogy, Improvement Strategies, Types of Problems PDSA Cycle, Problem-Solving Method, DMAIC, Kaizen, Reengineering, six sigma.	3
	Supplier Partnership: Principles of Customer/Supplier Relationship Partnering, Sourcing Supplier, Selection ,Supplier Certification Supplier Rating, Relationship Development.	2
	Performance Measures: Basic Concepts, Strategy, performance measure presentation, Cost of Quality, Malcolm Baldrige and Rajiv Gandhi National Quality Award, Balanced Score Card	3
III	Lean Enterprise: Historical Review, Lean Fundamentals, Value Stream Map, Implementing Lean, Benefits.	3
	Six Sigma: Historical Review, Statistical Aspects, Improvement Methodology, Organizational Structure Benefits.	3
	Benchmarking: Benchmarking Defined, Reasons to Benchmark, Process, deciding what to benchmark, Pitfalls and Criticisms.	2
IV	Quality Management Systems: Benefits of ISO Registration, ISO Series of Standards, ISO 9001 Requirements, Implementation, Documentation,	2
	Environmental Management Systems: ISO 14000 Series Standards,Concepts of ISO 14001, ISO 14001, Requirements, Benefits, Integrating QMS and EMS. Other EMS Systems,	2
	Quality Function Deployment: The QFD Team, QFD Process.	2
	Total Productive Maintenance: The Plan, Learning the New Philosophy, Promoting the Philosophy, Training, Improvement Needs, Goal,	2
V	Management Tools: Forced Field Analysis, Nominal Group Technique, Affinity Diagram, Interrelationship Digraph, Tree Diagram, Matrix Diagram, Process Decision Program Chart, Activity Network Diagram	2
	Experimental Design: Introduction, Basic Statistics, Hypothesis, t Test F Test. One Factor at a Time Orthogonal Design, Point and Interval Estimate, Two Factors Full Factorials. Fractional Factorials.	3
	Taguchi's Quality Engineering: Introduction, Loss Function, Orthogonal Arrays, Signal-to-Noise Ratio, Parameter Design,	3
	TOTAL	**40**

TEXT BOOK		
1	D. H. Besterfield, G. H Besterfield, Hemant Urdhwareshe, Total Quality Management: Revised Third Edition, Pearson Higher Education	2013
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year Pub.**
1	Total Quality Management: text with cases, John S Oakland, Butterworth-Heinemann	2003
2	Total Quality Management for Engineers, Zaire, M., Wood Head Publishing	1991
3	Total Quality Control, Feigenbaum. Armand V., McGraw Hill	1991
4	The Management and Control of Quality,(5th Edition), James R.Evans and William M.Lidsay, South-Western (Thomson Learning)	2002

Course outcome

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

CO1: Explain the concept of TQM and different theories of customer satisfaction.

CO2: Determine the basic concept of performance measures and different theories of continuous process improvement.

CO3: Determine the importance of lean enterprise, six sigma and bench marking system.

CO4: Evaluate the principles of quality management and how these principles can be applied within quality management systems.

CO5: Determine the management tools, experimental design and taguchi's quality engineering.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1	PSO2
CO1	1	1	1	1	1			2		2			
CO2	2	2	2	2	2			2		2			
CO3	2	1	1	1	1					2			
CO4	2	2	2	2	2					2			
CO5	2	1	1	1	1					2			
Average	**1.8**		**1.4**	**1.4**	**1.4**	**1.4**	**2.0**	**2.0**					

6PIU4: OPERATIONS RESEARCH

B.Tech. (P&I) 6th semester
3L+0T

Unit	Contents	Contact hours
I	**Overview of Operations Research**	1
	Linear Programming: Applications and model formulation, Graphical method, Simplex method, duality and Sensitivity analysis.	4
	Transportation Model and Assignment Model including travelling salesman problem.	4
II	**Integer Linear Programming:** Enumeration and cutting Plane solution concept, Gomory's all integer cutting plane method, Branch and Bound Algorithms, applications of zero-one integer programming.	5
	Replacement Models: Capital equipment replacement with time, group replacement of items subjected to total failure.	3
III	**Queuing Theory**: Analysis of the following queues with Poisson pattern of arrival and exponentially distributed service times, Single channel queue with infinite customer population, Multichannel queue with infinite customer population,	3
	Competitive Situations and Solutions: Game theory, two person zero sum game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy, approximate solution, and simplified analysis for other competitive situations. Application of linear programming	4
IV	Theory of Decision making: Decision making under certainty, risk and uncertainty. Decision trees.	5
	Deterministic Inventory control models: functional role of inventory, inventory costs, model building, Single item inventory control model without shortages, with shortage and quantity discount. Inventory control model with uncertain demand, service level, safety stock, P and Q systems, two bin system. Single period model. Selective Inventory control techniques.	4
V	**Probabilistic Inventory control models:** Instantaneous demand without setup cost and with setup cost, Continuous demand without setup cost	4
	Simulation: Need of simulation, advantages and disadvantages of simulation method of simulation. Generation of Random numbers, Generation of Normal Random numbers. Use of random numbers for system simulation. , Monte Carlo simulation, simulation language ARENA, Application of simulation for solving queuing Inventory Maintenance, Scheduling and other industrial problems	4
	TOTAL	40

TEXT BOOK		
1	Operations Research, Ravindran, Phillips and Solberg, Wiley India.	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Introduction to Operations Research, Hillier F.S. and Lieberman G.J., CBS Publishers.	2002
2	Operations Research, Taha H.A., Pearson Education	2012
3	Linear Programming and Network Flows, Bazaraa, Jarvis and Sherali, Wiley India.	2003
4	Principles of Operations Research, Wagner H.M., Prentice Hall of India.	2001
5	Operations Research, Gupta and Heera, S. Chand Publications.	2008

Course outcome

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

CO1: Discuss the concepts of operations research modelling approaches by formulating and solving engineering and managerial situations as LPP

CO2: Evaluate engineering and managerial situations as Transportation and Assignment problems.

CO3: Explain game and queuing theories.

CO4: Illustrate decision theory and estimate inventory management policy

CO5: Simulate and analyze engineering and managerial problems.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1	PSO2
CO1	3	3	2	1	1								
CO2	3	3	3	3	2								
CO3	3	3	3	2	2								
CO4	3	3	3	1	2								
CO5	3	3	3	3	3								
				Average		**3.0**	**3.0**	**2.8**	**2.0**	**2.0**			

6PIU5.1: MICRO AND NANO MANUFACTURING

B.Tech. (P&I) 6th semester
3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	Nanoscale Cutting:- Introduction, Material representation and microstructure, Atomic interaction, Nanometric machining	4
	Meso-micromcahining:- Introduction, size effects in micromachining, mechanism for large plastic flow, origin of the size effect, Meso-machining processes. Burr formation in micromachining operations.	4
II	Microturning:- Characteristic features and applications, Microturning tools and tooling systems, Machine tools for microturning	3
	Microdrilling: Characteristic features and applications, Microdrills and tooling systems, Machine tools for microdrilling Micromilling:- Characteristic features and applications, Micromills and tooling systems, Machine tools for micromilling,	3
III	**Microgrinding and Ultra-precision Processes:** Introduction, Micro and nanogrinding, Nanogrinding apparatus, Nanogrinding procedures, Nanogrinding tools, Preparation of nanogrinding wheels, Bonding systems, Vitrified bonding	4
	Non-Conventional Processes: Laser Micromachining:- Introduction, Fundamentals of lasers, Stimulated emission, Types of lasers, Laser microfabrication, Nanosecond pulse microfabrication, Shielding gas, Effects of nanosecond pulsed microfabrication, Picosecond pulse microfabrication, Femtosecond pulse microfabrication, Laser nanofabrication.	4
IV	**Evaluation of Subsurface Damage in Nano and Micromachining:** Introduction, Destructive evaluation technologies, Cross-sectional microscopy, Preferential etching, Angle lapping/angle polishing, X-ray diffraction, Micro-Raman spectroscopy.	4 4
V	**Applications of Nano and Micromachining in Industry:**Introduction, Typical machining methods, Diamond turning, Shaper/planner machining, Applications in optical manufacturing, Aspheric lens, Fresnel lens, Microstructured components, Semiconductor wafer production.	4 5
	TOTAL	**39**

TEXT BOOK		
1	Micro and Nano manufacturing by Marks J. Jackson springer	2008
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	J. Paulo Davim, Mark J. Jackson, Nano and Micromachining ISTE Ltd John Wiley & Sons, Inc.	2009

Course outcome

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

CO1: Interpretation of machining operations on micro and nano scale

CO2: Organize micro and nano manufacturing tools and processes

CO3: Analyze and evaluate the different surface damages during micro and nano manufacturing processes

CO4: Knowledge of micro and nano manufacturing industries

CO5: Learn about non-conventional micro and nano processes

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1 PSO2
CO1	3	2		2	2							
CO2	3	2		3	3							
CO3	3	3	2	3	1							
CO4	3	3		2	2							
CO5	3	2										
Average	**3.0**	**2.4**	**2.0**	**2.5**	**2.0**							

6PIU5.2: COMPUTER AIDED DESIGN AND GRAPHICS

B.Tech. (P&I) 6th semester

UNIT	CONTENTS	CONTACT HOURS
I	**Overview of Computer Graphics:** Picture representation, Coordinate Systems, Raster Scan Display, DDA for line generation and Bresenham's algorithm for line and circle generation; Graphics standards: GKS, IGES, STEP, DXF. Different types of models.	5
	Parametric representation of plane curves: line, circle, ellipse, parabola and hyperbola.	4
II	**Parametric representation of Space Curves:** Cubic spline curve, Bezier Curve and B Spline Curves. Blending of Curves.	4
	Parametric representation of Surfaces: Hermite Bicubic surfaces, Bezier surfaces and Bspline surfaces.	4
III	**Solid Representation:** B-rep. and CSG. Comparison between three types of models.	7
IV	**Two and Three Dimensional Transformation of Geometric Models:** Translation, Scaling Reflection, Rotation and Shearing, Homogeneous Representation, Combined Transformation.	4
	Projection of Geometric models: Parallel and Perspective Projection.	4
V	**Clipping:** Point clipping, Line clipping, Cohen- Sutherland algorithm etc., Viewing transformation.	4
	Hidden line and surface removal: Techniques and Algorithms. Shading and Rendering.	4
	TOTAL	40

TEXT BOOK		
1	Zeid and Sivasubramanian,CAD/CAM: Theory and Practice, Tata McGraw Hill	
2	Rogers and Adams, Mathematical Elements for Computer Graphics, Tata McGraw Hill	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Rao P.N., CAD / CAM Principles and Applications, McGraw Hill.	2004
2	Pao Y.C., Elements of Computer Aided Design and Manufacturing, John Wiley and Sons.	1984
3	Alavala C.R., CAD/CAM: Concepts and Applications, Prentice Hall of India.	2008
4	Xiang and Plastock, Computer Graphics, Schaum's Outlines, Tata McGraw Hill.	2007

CO1: Learn basic concepts of geometric modeling.
CO2: Acquire the theory of mathematical representation of geometric entities like curves and surfaces.
CO3: Access the solid modeling concept.
CO4: Learn the various algorithms to display geometric model realistically.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	2	2	2	-	-	-	-	-	-	-	-
C02	2	3	3	2	-	-	-	-	-	-	-	-
C03	3	3	2	2	-	-	-	-	-	-	-	-
C04	2	2	3	2	-	-	-	-	-	-	-	-

6PIU5.3: MAINTENANCE MANAGEMENT

B.Tech. (P&I) 7th semester

UNIT	CONTENTS	CONTACT HOURS
I	Introduction -Fundamentals of Maintenance Engineering. Maintenance Engineering its importance in material & energy conservation, inventory control, productivity, safety, pollution control etc.	3
	Safety Regulations, pollution problems, human reliability, total quality management (TQM), total productivity maintenance (TPM), environmental issues in maintenance, ISO 9000.	4
II	Maintenance Management - types of maintenance strategies, Planned and unplanned maintenance, breakdown, preventive & predictive maintenance.Their comparison, advantages & disadvantages. Limitations.	4
	Computer aided maintenance, maintenance scheduling, spare part management, inventory control, organisation of maintenance department.	4
III	Tribology in Maintenance, friction wear and lubrication, friction & wear mechanisms, prevention of wear, types of lubrication mechanisms, lubrication processes.	3
	Lubricants - types, general and special purpose, additives, testing of lubricants, degradation of lubricants, seal & packings.	3
	Repair methods for basic machine elements: Repair methods for beds, slideways, spindles, gears, lead screws and bearings–Failureanalysis–Failures and their development–Logical fault location methods–Sequentialfaultlocation.	3
IV	Machine Health Monitoring - Condition based maintenance, signature analysis, oil analysis, vibration, noise and thermal signatures, on line & off line techniques,	4
	Instrumentation & equipment used in machine health monitoring. Instrumentation in maintenance, signal processing, data acquisition and analysis, application of intelligent systems, data base design.	4
V	Reliability, availability & maintainability (RAM) Analysis - Introduction to RAM failure mechanism, failure data analysis, failure distribution, reliability of repairable and non repairable systems.	4
	Improvement in reliability, reliability testing, reliability prediction, utilisation factor, system reliability by Monte Carlo Simulation Technique.	4
	TOTAL	**40**

TEXT BOOK		
1	Anthony Kelly, Strategic Maintenance Planning, Butterworth-Heinemann	2006
2	R. C. Mishra, K. Pathak ,Maintenance Engineering and Management, PHI Learning Pvt. Ltd	2012
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Higgins L.R., "Maintenance Engineering Hand book", McGraw Hill	1988
2	Maintenance & Spare parts Management Gopal Krishnan	
3	Srivastava S.K., "Industrial Maintenance Management", S. Chand and Co	1981
4	Hand book of Condition Monitoring CNR Rao	
5	White E.N., "Maintenance Planning", I Documentation, Gower Press	1979
6	Armstrong, "Condition Monitoring", BSIRSA	1988
7	Davies, "Handbook of Condition Monitoring", Chapman &Hall,	1996

6PIU6.1:DATA ANALYTICS

B.Tech. (P&I) 6th semester

UNIT	CONTENTS	CONTACT HOURS
I	Introduction to Multivariate Statistics-Degree of Relationship among Variables-Review of Univariate and Bivariate Statistics-Screening Data Prior to Analysis-Missing Data, Outliers, Normality, Linearity, and Homoscedasticity.	**4**
II	Multiple Regression- Linear and Nonlinear techniques- Backward-Forward-Stepwise- Hierarchical regression-Testing interactions (2way interaction) - Analysis of Variance and Covariance (ANOVA & ANCOVA) - Multivariate Analysis of Variance and Covariance (MANOVA & MANCOVA).	**3**
III	Logistic regression: Regression with binary dependent variable - Simple Discriminant Analysis- Multiple Discriminant analysis-Assessing classification accuracy- Conjoint analysis (Full profile method).	**4**
IV	Principal Component Analysis -Factor Analysis- Orthogonal and Oblique Rotation-Factor Score Estimation-Multidimensional Scaling-Perceptual Map-Cluster Analysis (Hierarchical Vs Nonhierarchical Clustering).	**4**
V	Latent Variable Models an Introduction to Factor, Path, and Structural Equation Analysis- Time series data analysis (ARIMA model) – Decision tree analysis (CHAID, CART) - Introduction to Big Data Management.	**4**
	TOTAL	**39**

TEXT BOOK		
1	Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. “Multivariate data analysis”, (7th edition). Pearson India.	2015
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Tabachnick, B. G., & Fidell, L. S., “Using multivariate statistics”, (5th edition). Pearson Prentice Hall	2001
2	Gujarati, D. N. , “Basic econometrics”, Tata McGraw-Hill Education.	2012
3	Malhotra, N. K., “ Marketing research: An applied orientation”, 5/e. Pearson Education India.	2008
4	Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. “ Applied multiple regression/correlation analysis for the behavioral sciences”, Routledge..	2013
5	Han, J., Kamber, M., & Pei, J. “Data mining: concepts and techniques: concepts and techniques”, Elsevier.	2011

6PIU6.2: MANAGERIAL ACCOUNTING, FINANCE & ECONOMICS

B.Tech. (P&I) 6th semester

UNIT	CONTENTS	CONTACT HOURS
I	Concept and scope of Engineering Economics. Problem Solving and decisionmaking. Time Value of Money: Interest formulae and their applications.	3
	Cash Flow Diagrams. Single and multiple payment cash flows.	4
II	Methods of comparison of alternatives – present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram).	5
	Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method, Examples in all the methods.	4
III	Replacement studies: current salvage value of defender, replacement due to deterioration and obsolescence. Depreciation meaning and methods of computing depreciation-Straight line method of depreciation, declining balance method of depreciation, Sum of the years digits method of depreciation, sinking fund method of depreciation/ Annuity method of depreciation.	4
	Cost and Costs Control: Costs and Cost Accountancy: Meaning of cost and cost Accountancy (C.A.) Financial Accountancy (F.A.) comparison between C.A. and F.A.	
IV	Elements of cost Direct cost and indirect cost, variable costs and fixed cost calculation ofProduct cost, Cost control-Techniques of cost control.	4
	Budgets- Meaning Kinds, Advantages, Budgetary control. Inflation: Causes of inflation, consequences of inflation, measuring inflation, leasing/buying decisions. Break-Even analysis, linear break-even analysis, Break-Even charts and relationships, Non-linear break-even analysis.	3
V	Finance & Financial Statements: Introduction Needs of Finance, Kinds ofCapital Sources of fixed capital shares-ordinary and PreferenceShares. Borrow capital. Surplus profits: Sources of Working capital, Management of working capital, Financial Institutions.	4
	Financial Statement (i) Profit & Loss Statement (ii) Balance Sheet (B.S.) Financial ratios-current ratio, Liquidity ratio, Profits investment ratio, equity ratio and Inventory turn-over ratio. Management and Financial ratio, Money conversion cycle in the Business.	
	TOTAL	**40**

TEXT BOOK		
1	Engineering Economics, Riggs Bedworth, Tata McGraw Hill, New Delhi	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Engineering Economics and Costing, Sasmita Mishra, Prentice Hall of India	
2	Financial Planning Management and Control, Prasanna Chandra, Tata McGraw-Hill.	

6PIU6.3: DESIGN AND MANUFACTURING OF PLASTIC PRODUCTS

B.Tech. (P&I) 6th semester

UNIT	CONTENTS	CONTACT HOURS
I	**Plastics Materials**: An Overview, Classification, Thermoplastics, Thermosets, Crystalline, Amorphous, and Liquid, Additives, Reinforcements, and Fillers, Physical Properties and Terminology.	5
	Mechanical Properties, Thermal Properties, Electrical Properties, Environmental Considerations, Structural Analysis	3
II	**Design Considerations for Injection-Molded Parts**: Injection Molding Process, Design Strategy, Efficient and Functional Design, Material Selection,	2
	Nominal Wall Thickness, Normal Ranges of Wall Thickness, Structural Requirements of the Nominal Wall,	2
	Insulation Characteristics of the Nominal Wall, Impact Response of the Nominal Wall, Draft, Structural Reinforcement, Ribs, Other Geometric Reinforcement, Bosses, Coring, Fillets and Radii, Undercuts	4
III	Polymer processing techniques such as extrusion, compression and transfer moulding.	4
	Injection moulding, blow moulding, thermoforming, rotational moulding, calendaring.	4
IV	**Assembly:** General Types of Assembly Systems, Molded-In Assembly Systems, Snap-Fit Assembly, Molded-In Threads, Press-Fits, Chemical Bonding Systems, Solvent Welding, Adhesive Bonding, Thermal Welding Methods, Ultrasonic Welding, Vibration Welding,	4
	Spin Welding, Radio Frequency (RF) Welding, Electromagnetic or Induction Welding, Assembly with Fasteners, Bolted Assembly, Threaded Metal Inserts, Self-Tapping Screws, Riveted Assembly, Sheet Metal Nuts, Specialty Plastic Fasteners	4
V	**Machining of Plastics**: Drilling and Reaming,Thread Tapping, Sawing, Milling, Turning, Grinding and Routing	4
	Finishing and Decorating of Plastics: Painting, Vacuum Metallizing and Sputter Plating, Electroplating, Flame Spraying/Arc Spraying, Hot Stamping	4
	TOTAL	**40**

TEXT BOOK		
1	Design and Manufacture of Plastic Parts, R.L.E. Brown, John Wiley and Sons, New York	**1980**
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Designing with Plastics, Gerhard, Hanser Verlag	
2	Handbook of Plastics Joining: a practical guide, PDL handbook series, Plastics Design Library, William Andrew	
3	Modern Plastics Handbook, McGraw Hill handbooks, Modern plastics series, Charles A. Harper, McGraw-Hill Professional	**1997**
4	Industrial Plastics: theory and applications, Erik Lokensgard and Terry L. Richardson, 4th Edition,Cengage Learning	**2000**

Course outcome

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

CO1: Describe different plastic materials and their properties

CO2: Explain design Strategies of moulded parts and evalute nominal wall thickness & their insulation characteristics.

CO3: Discuss different moulding processes

CO4: examine general types assembly systems, variuos weldings and fasteners

CO5: Illustrate machining and finishing processes

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1	PSO2
CO1	3	2	1	1			1						
CO2	2	3	3	1									
CO3	3	2	1	1			1						
CO4	2	2	3	1									
CO5	2	1	3	1									
Average	**2.4**	**2.0**	**2.2**	**1.0**			**1.0**						

6PIU11: METAL CUTTING LAB.

B.Tech. (P&I) 6th Semester
0L+0T+3P

SN	NAME OF EXPERIMENT
1	Find out Chip reduction co-efficient (reciprocal of chip thickness ratio) during single point turning.
2	Forces measurements during orthogonal turning.
3	Estimation of Power required during orthogonal turning.
4	Torque and Thrust measurement during drilling.
5	Forces measurement during plain milling operation.
6	Measurement of Chip tool Interface temperature during turning using thermocouple technique.
7	Exercise involving cylindrical grinding on surface grinding machine.
8	Study the variation of surface roughness with different speed and feed during plain milling operation on flat surface.
9	Study of capstan lathe and its tooling and prepare a tool layout & job as per given drawing.
10	Engrave a profile on given workpiece using EDM machine.
11	Exercises for boring of cylindrical bores and machining of external surfaces coincident with internal bores on boring machine.

Course outcome

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

CO1: Measurement of chip reduction coefficient , various forces on tool and power during orthogonal turning

CO2: analyze thrust and torque during drilling

CO3: evaluate chip tool interface temperature during turning using thermocouple technique

CO4: study of variation of surface roughness with different speed and feed during plain milling operation on flat surface

CO5: making a job on capstan lathe , grinding machine , boring and EDM machine

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1	PSO2
CO1	3	3	1	2	1								
CO2	3	3	2	2	1								
CO3	3	3	2	2	1								
CO4	3	3	1										
CO5	3		2	2	1								
		Average		**3.0**	**3.0**	**1.6**		**2.0**	**1.0**				

6PIU12: INDUSTRIAL ENGINEERING LAB-I

B.Tech. (P&I) 6th Semester
0L+0T+3P

SN	NAME OF EXPERIMENT	CONTACT HOURS
	Case Study on the following:	
1	Work Methods Design	
2	Location Planning	
3	Systematic Layout Planning	

4	Process Control Charts	
5	Productivity	
6	Project Management	
7	Materials Management	
8	Capacity Planning	

Course outcome

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

CO1: Examine long term decision of location , layout and capacity planning.

CO2: Construct process control chart.

CO3: Develop work methods and improve productivity

CO4: Model various inventory management system

CO5: Construct project management of real life problem

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1
	PSO1	PSO2										
CO1	3	3	3	3	1				1			1
CO2	3	2	2	3	1							
CO3	3	2	2	3	1				2			1
CO4	3	2	3	3	2				1			2
CO5	3	3	3	3	1	2	2		1			1
Average	**3.0**	**2.4**	**2.6**	**3.0**	**1.2**	**2.0**	**2.0**		**1.3**			**1.3**

6PIU13: OPERATIONS RESEARCH LAB.

B.Tech. (P&I) 6th Semester

0L+0T+2P **Exam Hours: 2**

SN	LABORATORY WORK/NAME OF EXPERIMENT
	Solve using software and verify with analytical methods
1	Linear programming problem
2	Assignment problem
3	Transportation problem
4	Integer programming problem
5	Queuing Problem
6	Inventory problem
7	Simulation Problem
8	Replacement Problem
9	Decision Tree
10	Game theory

6PIU14: STATISTICAL LAB.

B.Tech. (P&I) 6th Semester

SN	LABORATORY WORK/NAME OF EXPERIMENT
	Solve using software and verify with analytical methods
1	**Hypothesis Testing** • Mean: One-Sample z-test, Two-sample z-test, One-Sample t-test, Two-Sample t-test, Paired t-test, Poisson test with Bonferroni, Dunn-Sidak adjustments • Variance: Single Variance, Equality of Two Variances, Equality of Several

	Variances • Correlation: Zero Correlation, Specific Correlation, Equality of Two Correlations • Proportion: Single Proportion, Equality of Two Proportions • Appropriate Quick Graphs • Resampling – Bootstrap, without replacement, Jackknife
2	**Descriptive Statistics** • Coefficient of variation, std err of mean • Adjustable confidence intervals of mean • Skewness, kurtosis, including standard errors
3	**Design of Experiments** • Complete and incomplete factorial designs • Latin square designs, 3-12 levels per factor • Box and Hunter 2-level incomplete designs • Taguchi designs
4	**ANOVA** • Designs: unbalanced, randomized block, complete block, fractional factorial, mixed model, nested, split plot, Latin square, crossover and change over, • ANCOVA • Means model for missing cells designs • Repeated measures: one-way, two or more factors, three or more factors • Options to test normality and homoscedasticity assumptions • Type I , II and III sums of squares
5	**Time Series** • Smoothing: LOWESS, moving average, running median, and exponential • Seasonal adjustment • Fourier and inverse Fourier transforms • Box-Jenkins ARIMA model • Specify autoregressive, difference and moving average parameters • Forecast and standard errors

7PIU1: METAL FORMING PROCESSES

B.Tech. (P&I) 7th semester

Unit	Contents	Contact hours
I	**FUNDAMENTALS OF METAL FORMING** Classification of forming processes, Mechanics of metal working, Flow stress determination, Temperature in metal working, strain rate effects, metallurgical structures, deformation zone theory, hydrostatic pressure, residual stresses, Spring back	3
	Review of state of stress – Components of stress, behavior of metal when subjected to stress, Introduction to stress tensor, principal stresses, Stress deviator, Mohr's circle of stress (two dimension and three dimensions), Mohr's circle of strain, von-mises, Tresca yield criteria.	5
II	**FORGING:** Classification, equipment, forging in plain strain, open-die forging, closed-die forging, calculation of forging loads in closed-die forging, forging defects, powder metallurgy forging, residual stresses in forging.	4
	ROLLING: Classification, Rolling mills, hot and cold rolling, rolling of bars and shapes, forces and geometrical relationships, simplified analysis of rolling load: rolling variables, Problems and defects in rolled products, theories of cold and hot rolling, torque and power.	4
III	**EXTRUSION:** Classification of extrusion processes, equipment, hot extrusion, deformation, lubrication and defects in extrusion, analysis of the extrusion process, cold extrusion and cold forming, hydrostatic extrusion, extrusion of tubing, influence of friction, extrusion force calculation, production of seamless pipe and tubing.	4
	DRAWING OF RODS, WIRES AND TUBES; Introduction, rod and wiredrawing, analysis of wiredrawing, tube-drawing processes, analysis of tube drawing, residual stresses in road, wire, and tubes, defects, Tube drawing and sinking processes, Tube bending.	4
IV	**SHEET METAL FORMING:** Classification – conventional and HERF processes – presses – types and selection of Presses, forming limit criteria, Limiting Draw ratio - processes: Deep drawing,	3
	spinning, stretch forming, plate bending, Rubber pad forming, bulging, Explosion forming, electro hydraulic forming, Magnetic pulse forming.	5
V	**RECENT ADVANCES:** Super plastic forming – Electro forming – fine blanking – Hydro forming – Peen forming – LASER Forming –	4
	Micro forming - P/M forging – Isothermal forging – high speed hot forging – near net shape forming, high velocity extrusion – CAD and CAM in forming	4
	TOTAL	40

TEXT BOOK		
1	Rao, P.N. "Manufacturing Technology", Vol 2, 3 TMH Ltd.,	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Nagpal G.R. "Metal forming processes", Khanna publishers.	
2	Serope Kalpakjian, Steven R Schmid, "Manufacturing Process for Engineering Materials" – Pearson Education	
3	Edward M. Mielink, "Metal working science Engineering, McGraw Hill, Inc,.	
4	Metal Hand book Vol.14, "Forming and Forging", Metal Park, Ohio, USA.	
5	Dieter G.E., "Mechanical Metallurgy", McGraw Hill, Co., S.I.	

Course outcome

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

CO1: Distinguish between different metal forming process

CO2: Analyse the parameters involved in Forging ,Rolling, Extrusion and wire drawing

CO3: Evaluate the force estimation for bulk and sheet metal operations

CO4: compare and judge the appropriate forming operation for specific work

CO5: Recognise the Advanced metal forming process such as , Laser forming , micro forming, super plastic forming etc

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1	PSO2
CO1	3	2	2	1	2								
CO2	3	3	2	1	2								
CO3	2	3	2	2									
CO4	3	3	2	2									
CO5	3	3	2	2	3								
		Average		2.8	2.8	2.0	1.6	2.3					

7PIU2: OPERATIONS PLANNING AND CONTROL

B.Tech. (P&I) 7th semester

UNIT	CONTENTS	CONTACT HOURS
I	Introduction to operations management (OM), the scope of OM; Historical evolution of OM; Trends in business; the management process. Operations Strategy, Competitiveness and Productivity	3
	Demand Forecasting: components of forecasting demand,Approaches to forecasting: forecasts based on judgment and opinion, Time series data. Associative forecasting techniques, Accuracy and control of forecasts, Selection of forecasting technique.	4
II	Product and Service design, Process selection, Process types, Product and process matrix, Process analysis.	3
	Capacity Planning: Defining and measuring capacity, determinants of effective capacity, capacity strategy, steps in capacity planning process, determining capacity requirements, Capacity alternatives, Evaluation of alternatives; Cost-Volume analysis.	2
III	Planning levels: long range, Intermediate range and Short range planning, Aggregate planning: Objective, Strategies, and techniques of aggregate planning.	4
	Master scheduling; Bill of materials, MRP; inputs processing and outputs, and overview of MRPII , use of MRP to assist in planning capacity requirements, Introduction to ERP	4
IV	Production Control: Capacity control and priority control, production control functions; Routing, scheduling, dispatching, expediting and follow up. Techniques of production control in job shop production, batch production and mass production systems.sequencing: priority	4

	rules, sequencing jobs through two work centers, scheduling services	
	Introduction to Just-in-time (JIT) and Lean Operations: JIT production, JIT scheduling, synchronous production, Lean operations system	**4**
V	Supply Chain Management (SCM): Need of SCM, Bullwhip effect, Elements of SCM, Logistics steps in creating effective supply chain, Purchasing and supplied management.	**3**
	Project Management: Nature of projects, project life cycle, Work breakdown structure, PERT and CPM, Time-Cost trade-offs: Crashing.Resource allocation, leveling	**5**
	TOTAL	**40**

TEXT BOOK		
1	Stevenson, Operations Management, Tata McGraw Hill.	2009
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Roberta S. Russell, Bernard W. Taylor, Operations Management, John Wiley & Sons	2010
2	Joseph S. Martinich, Production And Operations Management, John Wiley & Sons	2008
3	S.N. Chary, Production and Operations Management, Tata McGraw Hill	2009
4	Norman Gaither, Greg Frazier, Operations Management, Thomson Learning	2002

Course outcome

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

CO1: Explain operation management & strategies.

CO2: Calculate & analyse forecasting. inventory & supply chain.

CO3: Prepare aggregate plans and capacity plans.

CO4: Compute lot size using MRP and other lot sizing techniques.

CO5: Prepare project networks using PERT and CPM networks.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1	PSO2
CO1	1	1	2										1
CO2	3	2	2			2	2						1
CO3	3	2	2	3	3								1
CO4	3	2	2	2									1
CO5	3	3	2	2	3	2	2	2					1
Average	**2.6**		**2.0**	**2.0**	**2.3**	**3.0**	**2.0**	**2.0**	**2.0**	**1.0**			

7PIU3: ADVANCED MANUFACTURING METHODS

B.Tech. (P&I) 7th semester

UNIT	CONTENTS	CONTACT HOURS
I	Introduction and classification of advanced machining process, consideration in process selection, difference between traditional and non-traditional process, Hybrid process.	3
II	**Abrasive finishing processes**: AFM, MAF (for Plain and cylindrical surfaces).	4
III	**Mechanical advanced machining process**: Introduction, Mechanics of metal removal, process principle, Advantages, disadvantages and applications of AJM,USM,WJC.	5
IV	**Thermo electric advanced machining process**: Introduction, Principle, process parameters,advantages, disadvantages and applications about EDM, EDG,	4
	LBM, PAM, EBM	6
V	**Electrochemical and chemical advanced machining process**: ECM, ECG, ESD, Chemical machining,	5
	Anode shape prediction and tool design for ECM process. Tool (cathode) design for ECM Process.	3
	TOTAL	40

TEXT BOOK		
1	Modern Machining Process, Pandey and Shan, Tata McGraw Hill	1980
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Advance Machining Process, Jain V.K., Allied Publishers Ltd.	2002
2	Non Traditional Manufacturing Process, Gary F. Bevedict, Marcel Dekker Inc New York.	1987
3	Non-Conventional Machining Process, Mishra P.K., Narosa Publishing House	2006
4	Non-Conventional Machining Process, J.A. McGeough	1988
5	Rapid Prototyping: principles and applications, Chee Kai Chua, Kah Fai Leong and Chu Sing Lim,2nd Edition, World Scientific	2003
6	Rapid Prototyping: Theory and Practice, Ali Kamrani, Emad Abouel Nasr and Springer; 1st Edition,	2006

7PIU4: COMPUTER INTEGRATED MANUFACTURING

B.Tech. (P&I) 7th semester

3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	**Introduction to CIM:**Overview of Production Systems, the product cycle, Automation in Production Systems, computer's role in manufacturing, sources and types of data used in manufacturing. The Beginning ofCAM: Historical Background,	2
	Introduction to manufacturing System, Classification of manufacturing system, overview of classification scheme, manufacturing progress functions.	3
II	Computer Aided Process Planning (CAPP): Traditional Process Planning,Retrieval process planningsystem, Generative Process Planning, Machinability data systems, computer generated timestandards.	8
III	Group Technology (GT): Introduction, part families, part classification and coding, codingsystem and machining cells. Introduction to Product data Management System (PDM)	4
	Computer Aided Production Management Systems (CAPM): Introduction to computer aided PPC, Introduction tocomputer aided inventory management, manufacturing resource planning (MRPII), computer processmonitoring and shop floor control, and computer process control.	5
IV	Computer Aided Quality Control (CAQ); Computer in quality control, Off-Line and On-Line Quality control, Automated inspection, contact inspection methods, Non contact inspection methods: optical and non opticalcomputer aided testing. Overview of automatic identification methods.	5
	Flexible manufacturing systems (FMS). Types of FMS, Flexibility in manufacturing, FMS components, FMS applications and benefits.	4
V	Product Design and CAD/CAM in the production system: Introductory concepts Product design and CAD, CAM,CAD/CAM and CIM	4
	Collaborative Engineering; Introduction, Faster Designthroughput, Web based design, Changing design approaches, extended enterprises, concurrentengineering, Agile and lean manufacturing.	5
	TOTAL	**40**

TEXT BOOK		
1	Mikell P. Groover, , Automation, Production Systems, and Computer-Integrated Manufacturing, 3rd ed., Pearson/Prentice Hall,	2008
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	James A. Rehg and Henry W. Kraebber, Computer-Integrated Manufacturing, 3rd ed., Pearson/Prentice Hall,	2005
2	Nanua Singh, Systems Approach to Computer-Integrated Design and Manufacturing, John Willey & Sons.	1996
3	Computer Aided Manufacturing, Chang, Wysk and Wang, Pearson Education	2008
4	CAD/CAM: Principles and Applications, P.N. Rao, McGraw Hill	2003
5	Computer Control of Manufacturing Systems,Y. Koren, McGraw Hill	2009
6	Computer aided Manufacturing, Rao, Tiwari and Kundra, Tata McGraw Hill.	2002
7	Computer Numerical Control: Machining and Turning Centres, Quesada and Jeyepoovan, PearsonEducation	2007

Course outcome

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

CO1: Describe the elements of the CIMS

CO2: Explain computer aided process planning

CO3: Discuss and solve the problem in part coding system in GT and PDM

CO4: Explain computerised quality control

CO5: Construct the product design, CAD/CAM in production system and collaborative engineering

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1 PSO2
CO1	3	2	1		3							
CO2	3	3	2		3							
CO3	3	3	3		3							
CO4	3	3	3		3							
CO5	3	3	3	1	3	1						
Average	**3.0**	**2.8**	**2.4**	**1.0**	**3.0**	**1.0**						

7PIU5.1: MODELING AND SIMULATION

B.Tech. (P&I) 7th semester
3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	**Physical modeling :** Concept of system and environment, continuous and discrete system, linear and nonlinear system, stochastic activities, static and dynamic models, principles used in modeling, Basic simulation modeling,	4
	Role of simulation in model evaluation and studies, Advantages and Disadvantages of simulation. Modeling of Systems, iconic analog. Mathematical Modeling	4
II	**Computer system simulation:** Technique of simulation, Monte Carlo method, experimental nature of simulation, numerical computation techniques, continuous system models, analog and hybrid simulation, feedback systems,	4
	Buildings simulation models of waiting line system, Job shop, material handling and flexible manufacturing systems	4
III	**Probability concepts in simulation:** Stochastic variables, discrete and continuous probability functions, random numbers, generation of random numbers,	4
	Variance reduction techniques, Determination of the length of simulation runs, Output analysis.	4
IV	**System dynamics modelling:** Identification of problem situation, preparation of causal loop diagrams and flow diagrams, equation writing, level and rate relationship.	5
	Simulation of system dynamics model.	3
V	**Verification and validation:** Design of simulation experiments, validation of experimental models, testing and analysis.	4
	Simulation languages comparison and selection, study of SIMULA, DYNAMO, STELLA, POWERSIM. Simulation softwares.	4
	TOTAL	**40**

TEXT BOOK		
1	Simulation Modeling and Analysis, Law A.M., McGraw Hill.	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Discrete-Event System Simulation, Banks and Carsan, Prentice Hall of India	
2	Simulation Modeling and Analysis with ARENA, Altiok and Melamed, Academic Press	
3	Simulation with ARENA, Keltan, Sadowski and Turrock, McGraw Hill	
4	Simulation Modeling and ARENA, Rossetti and Taha, John Wiley and Sons	
5	Dynamic Systems: Modeling, Analysis and simulation, Finn Hangen, Tapir Academic Press	

7PIU5.2: SUPPLY CHAIN MANAGEMENT

B.Tech. (P&I) 7th semester

3L+0T

Contents	Contact Hours
Introduction to Supply Chain Management: Supply chain – objectives – importance – decision phases – process view – competitive and supply chain strategies – achieving strategic fit – supply chain drivers – obstacles – framework – facilities – inventory – transportation – information – sourcing -pricing	7
Designing the supply chain Network: Designing the distribution network – role of distribution – factors influencing distribution – design options – e-business and its impact – distribution networks in practice design in the supply chain – role of network – factors affecting the network design decisions	4
Designing and planning for transportation network: Role of transportation - modes and their performance – transportation infrastructure and policies - design options and their trade-offs – Tailored transportation.	4
Sourcing & pricing Sourcing – In-house or Outsource – 3rd and 4th PLs – supplier scoring and assessment, selection – design collaboration – procurement process – sourcing planning and analysis. Pricing and revenue management for multiple customers, perishable products, seasonal demand, bulk and spot contract.	4
Dimensions of Logistics: Introduction, Nature and Concepts, Evolution; Supply Chain Management, Logistical Mission and Objectives; Components and Functions of Logistics Management; Integrated Logistics Management; Key Distribution-Related issues and Challenges and Strategic Logistics Management; Total Cost Analysis and Trade-off	3
Inventory Management: Introduction, Concept, types, Functions; Elements of Inventory Costs; Inventory Management under certainty, Managing Finished Products Inventory under Uncertainty, Strategic Inventory Management Tools and Techniques; Distribution Requirement Planning.	3
Supply Chain Integration: Introduction – push, pull and push–pull systems – push – based supply chains – pull – based supply chain – push-pull supply chain - identifying the appropriate supply chain strategy – implementing a push-pull strategy – demand – driven – strategies – the impact of the internet on supply chain	3
Strategies: distribution strategies – direct shipment – cross docking – trans shipment – centralized versus decentralized control – central versus local facilities.	
Decision-support systems for supply chain management: Introduction – the challenges of modeling – structure of decision support systems – input data – analytical tools – presentation tools – supply chain decision – support systems.	
	40

TEXT BOOK		
1	Donald J Bowersoy & David J Closs, Logistical Management- - TataMcGrawHill	
2	R P Mohanty & S G Deshmukh, Supply Chain Management- Theories & Practice	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub. Year**
1	Sunil Chopra, Supply Chain Management-–Pub: Peter Meindi	
2	Badi N V , Supply chain Management- - Pub : Vrindra Publications (P) Ltd. , Delhi	
3	Sunil Sharma , Supply Chain Management- Concept, Practice & Implementation –- Pub: Oxford Univ. Press	
4	Sople- Logistics Management-Pub.- Pearson edition-2013	
5	Desai K D – Six Sigma, Pub. Himalaya Publishing house	
6	Ray & Ruben- Stores Management, Pub. Himalaya Publishing House	

CO1: **Describe** the basic concepts of operations management and production systems
CO2: **Analyse** and **solve** the problems of production planning, scheduling & control.
CO3: **Understand** the concepts of MRP, JIT and SCM.
CO4: **Solve** the problems using project management & reliability.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	1	1	2	-	-	-	-	-	-	-	-	-
C02	1	3	3	3	-	-	-	-	-	-	-	-
C03	1	3	3	3	2	-	-	-	-	-	-	-
C04	1	1	2	3	1	-	-	-	-	-	-	-

7PIU5.3: RAPID PROTOTYPING

B.Tech. (P&I) 7th semester
3L+0T

Contents	Contact Hours
Overview of Rapid Product Development (RPD). Product Development Cycle;	**3**
Definition of RPD; Components of RPD. Rapid Prototyping (RP);Principle of RP; Technologies and their classifications;	**4**
Selection of RP process; Issues in RP; Emerging trends.	**4**
Rapid Tooling (RT);Introduction to RT, Indirect RT process-Silicon rubber molding, Epoxy tooling, Spray metal tooling and Investment Casting, Direct RT processes-Laminated Tooling, Powder Metallurgy based technologies, Welding based technologies, Direct pattern making (Quick Cast, Full Mold Casting),	**4**
Emerging Trends in RT, Reverse Engineering: Geometric data acquistion,3D reconstruction, Applications and Case Studies, Engineering applications, Medical applications.	**3**
Processing Polyhedral Data: Polyhedral BRep modeling, STL format, Defects and repair of STL files,	**3**
Overview of the algorithms required for RP&T and Reverse Engineering-slicing, support generation, feature recognisation etc.	**3**
TOTAL	**40**

TEXT BOOK		
1	C.K. Chua , K.F. Leong , C.S. Lim, Rapid Prototyping: Principles And Applications, World Scientific Publishing Co Pte Ltd; 3rd Revised	2008
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
2	Ali K. Kamrani , Emad Abouel Nasr,Rapid Prototyping: Theory And Practice (Manufacturing Systems Engineering Series) ,Springer-Verlag New York Inc	2006
3	Stucker, David W. Rosenand Ian Gibson, Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, And Direct Digital Manufacturing, Springer New York.	2014
4	Neil Hopkinson , Richard Hague , Philip Dickens, Rapid Manufacturing: An Industrial Revolution For The Digital Age 1st Edition,Wiley New York;	2005
5	Chee Kai Chua, Kah Fai Leong, 3d Printing And Additive Manufacturing: Principles And Applications , Fourth Edition Of Rapid Prototyping, World Scientific Publishing Company;	, 2014

7PIU11: METAL FORMING AND TOOL DESIGN LAB.

B.Tech. (P&I) 7th Semester

SN	NAME OF EXPERIMENT
Perform any ten experiments from the list given below	
1	Study of the effect of clearance and shear angle on the blanking and piercing operations
2	To determine the effect of percentage of reduction and the semi-cone angle of the die on the drawing load.
3	To find the effect of percentage of reduction and the die geometry on extruding force.
4	Experimental determination of wire drawing force for wire drawing operation.
5	Study of the drop forging operation (flowability, forging load etc by plasticine model.
6	To determine roll load in the sheet rolling process.
7	Students will be given at least one practical problem regarding the design and fabrication of Jigs & Fixture or Press tool.
8	Working drawings of the following:- Drilling Jigs (Box type, Leaf type, Indexing type, Trunion type etc.), Milling Fixtures, Grinding fixtures, Assembly and welding fixtures (for automobile components and frames etc.), Drawing Dies, Bending Dies, Compound Dies, Combination Dies & Progressive Dies.
9	Determination of true stress true strain relationship.
10	To mount die assembly on power press and produce the desired blanks.
11	To mount forming die assembly and to form a cup of M S Sheet.
12	Study of sheet gauges and sheet metal working machines and preparing a funnel using shear, circle cutting machine, ending rollers and spot wring machine.
13	Determine the drawing force component during wire drawing operation using wire drawing dynamometer.

7PIU12: CIMS Lab(CAM, IE & SIMULATION Practicals)

B.Tech. (P&I) 7th Semester

SN	NAME OF EXPERIMENT
1	To prepare part programming for plain turning operation.
2	To prepare part program for turning operations using turning cycle.
3	To prepare part program for threading operation.
4	Toprepare part program for gear cutting using mill cycle.
5	To prepare part program for multiple drilling in X and Z axis using drilling cycle.
	Case Study on the following:
1	Work Methods Design
2	Process Control Charts
3	Materials Management
4	Capacity Planning
	Simulation experiments
1	Generate Pseudo Random No. using different Techniques
2	Develop an Analytical Model for a given physical system
3	Develop a Monte-Carlo Simulation Model for a given physical system
4	Find a area of an irregular 2-D shape using Monte-Carlo Simulation
5	Find the effectiveness of simulation on a physical Stochastic System
6	Develop an algorithm for a selected Simulated Study and write the program in a high level language.
7	Modeling of manufacturing system using simulation software such as ARENA

7PIU13: PROJECT STAGE –I

Course outcome

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

CO1: Identify a real life problem or industrial problem.

CO2: Collect and analyse possible solutions, examine technical and economic feasibility of the solution.

CO3: Design promising solution considering environment and sustainability.

CO4: Prepare DPR(Detailed Project Report) and present.

CO5: Grasp the norms for performing in team.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1
	PSO1	PSO2										
CO1	2	3			1	1	2	1	3	1	2	3
CO2	2	3	3	1	1	1	2	1	3		2	3
CO3	2	3	3	3	2	2	3	1	3		3	3
CO4	2	2	1	1	1			1	2	3	2	3
CO5								1	3	2	1	2
Average	**2.0**	**2.8**	**2.3**	**1.7**	**1.3**	**1.3**	**2.3**	**1.0**	**2.8**	**2.0**	**2.0**	**2.8**

7PIU14: PRACTICAL TRAINING AND INDUSTRIAL VISIT

Course outcome

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

CO1: Explore the recent technological development through visiting the industries

CO2: Discover the various theoretical aspects in real time industrial scenario

CO3: Simulate and practice the concept in real situations

CO4: Collect data and prepare reports on the experiments/field visit

CO5:

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1
	PSO1	PSO2										
CO1	1	1				1	2		2	3		2
CO2	2	2	1		2	2	1		2	2	2	3
CO3	2	3	2	2	3	1	1	1	2	2	2	2
CO4	2	2	1	3	3	1			2	3	2	2
Average	**1.8**	**2.0**	**1.3**	**2.5**	**2.7**	**1.3**	**1.3**	**1.0**	**2.0**	**2.5**	**2.0**	**2.3**

8PIU1.1: NEW ENTERPRISE AND INNOVATION MANAGEMENT

B.Tech. (P&I) 8th semester

3L+0T

Unit	CONTENTS	Contact Hours
I	Entrepreneurship: Entrepreneurship and enterprise: Concept, role in economic development. Entrepreneurial competencies: awareness, assessment and development. Simulation exercise on goal setting in entrepreneurship. Entrepreneurial & Intrapreneurial mind. International entrepreneurship opportunities. Starting the venture: Generating business idea – sources of new ideas, methods of generating ideas, creative problem solving, opportunity recognition; environmental scanning, competitor and industry analysis; feasibility study – market feasibility, technical/operational feasibility, financial feasibility.	**8**
II	Business Plan: Emerging Business Opportunities-sources & assessment. Business Plan: Concepts, Methods, analysis & interpretation. Functional plans: Marketing plan – marketing research for the new venture, steps in preparing marketing plan, contingency planning; organizational plan – form of ownership, designing organization structure, job design, manpower planning; Financial plan: cash budget, working capital, proforma income Statement, proforma cash flow, proforma balance sheet, break even analysis.	**7**
III	Sources of finance: Sources of external finance, short term as well as long term, Debt or equity financing, commercial banks, venture capital; financial institutions supporting entrepreneurs; legal issues –intellectual property rights patents, trade marks, copy rights, trade secrets, licensing; franchising.	**8**
IV	Start Up: Institutional support to start up and incentives for SSI. Statutory obligation in starting a unit (general like Income Tax, VAT, CST or GST, Service tax, excise and customs, labour laws, etc. Start up strategies. Dealing with outside agencies like consultant, contractors, etc. Key marketing issue of new venture. Starting a franchising business. Starting an e-commerce venture. Buying arunning business. Managing growing venture: Growth, objective and strategy. Managing growth. Assessing resource from external sources, for financing growth including public issue, merger, amalgamation, joint venture, collaboration & selling business.	**8**
V	Innovation Management: an introduction, organizational setups that facilitate innovations. Management of research and development. Strategic alliances and network. Incubators and Accelerators.	**7**
	TOTAL	**40**

TEXT BOOK
1 Hisrich, Robert D., Michael Peters and Dean Shephered, Entrepreneurship, Tata McGraw Hill,New Delhi.
REFERENCE BOOKS
Name of Authors /Books /Publisher
1. Barringer, Brace R., and R., Duane Ireland, Entrepreneurship, Pearson Prentice Hall, New Jersy,USA. 2. Lall, Madhurima, and Shikha Sahai, Entrepreneurship, Excel Book, New Delhi. 3. Charantimath, Poornima, Entrepreneurship Development and Small Business Enterprises,Pearson 4. Paul Trot, Innovation Management and New Product Development, Pearson Education 5. P Narayana Reddy, Entrepreneurship : Text and Cases, Cengage 6. Murdick, Ross & Claggett. Information Systems for Modern Management,. PHI of India.

CO1: **Understand** entrepreneurship and entrepreneurial process and its significance in economic development.
CO2: **Develop** an idea of the support structure and promotional agencies assisting ethical entrepreneurship.
CO3: **Identify** entrepreneurial opportunities, support and resource requirements to launch a new venture within legal and formal framework.
CO4: **Develop** a framework for technical, economic and financial feasibility.
CO5: **Evaluate** an opportunity and prepare a written business plan to communicate business ideas effectively.
CO6: **Understand** the stages of establishment, growth, barriers, and causes of sickness in industry to initiate appropriate strategies for operation, stabilization and growth.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	1	-	-	3	-	-	3
CO2	-	-	-	-	-	-	1	2	-	1	-	1
CO3	-	-	-	-	-	2	3	2	2	2	1	2
CO4	-	-	-	-	-	-	2	-	-	1	2	2
CO5	-	-	-	-	-	3	-	2	-	3	1	2
CO6	-	-	-	-	-	-	-	2	2	2	2	3

8PIU1.2: ENGINEERING OPTIMIZATION

B.Tech. (P&I) 8th semester
3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	**Introduction**- Engineering Applications of Optimization-Statement of an Optimization Problem-Classification of Optimization Problems-Optimization Techniques	5
II	**Classical Optimization Techniques**-Single-Variable Optimization-Multi variable Optimization with No Constraints-Multivariable Optimization with Equality Constraints- Multivariable Optimization with Inequality Constraints- Transportation	4
III	**Nonlinear Programming I**: 1DMinimization Methods-Unimodal Function, Elimination Methods-Unrestricted Search, Exhaustive, Dichotomous Search- Interval Halving Method- Fibonacci Method-Golden Section Method, Interpolation Methods-Quadratic, Cubic Interpolation Method - Direct Root Methods-Newton Method-Quasi-Newton, Secant Method	7
IV	**Nonlinear Programming II**: Unconstrained Optimization Techniques-Direct Search Methods- Indirect Search (Descent) Methods, Non-linear Programming III: Constrained Optimization Techniques- Direct Methods-Indirect Methods, Geometric Programming, Dynamic Programming, Integer Programming –Integer Linear Programming - Stochastic Programming.	4
V	**Modern Methods of Optimization**- Genetic Algorithms-Simulated Annealing-Particle Swarm Optimization- AntColony Optimization-Optimization of Fuzzy Systems- Neural- Network- Based Optimization, Practical Aspects of Optimization	4
	TOTAL	**40**

TEXT BOOK		
1	Kalyanmoy Deb, "Optimization for Engineering design –algorithms & examples", PHI, New Delhi	1995
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Singiresu S.Rao, "Engineering optimization– Theory and practices", John Wiley and Sons,	1998.
2	Garfinkel, R.S. and Nemhauser, G.L., "Integer programming", John Wiley & Sons,	1972.

CO1: **Describe** the basic concepts of engineering optimization.
CO2: **Solve** the problems using different techniques of optimization.
CO3: **Understand and implement** the modern methods of optimizations.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	2	2	-	1	-	-	-	-	-	-	-	-
C02	3	3	2	2	1	-	-	-	-	-	-	-
C03	3	3	2	1	3	-	-	-	-	-	-	-

8PIU2.1: PRODUCT DEVELOPMENT AND LAUNCHING

B.Tech. (P&I) 8th semester

3L+0T

Unit	Contents	Contact Hours
I	**Importance of New Product:** Definition-importance-Development Process, Importance of new product for growth of enterprise, Definition of product and new product,	2
	Responsibility for new product development, Demands on product development team, Classification of products from new product development point of view- Need based/Market pull products, Tech. push, Platform based, Process based and customized products,	3
	New product development process and organization, Generic product development process for Market Pull Products, Modification of this process for other types of products.	3
II	**Need Analysis:** Problem Formulation Establishing economic existence of need, Need Identification and Analysis, Engineering Statement of Problem, Establishing Target Specification.	8
III	**Generation of Alternatives and Concept Selection:** Concept generation-a creative process, Creativity, Road Elects to creative thinking-Fear of criticism and Psychological set,	4
	Tools of creativity like brain storming, Analogy, Inversion etc., Creative thinking Process, Concept feasibility and Concept Selection, Establishing Engineering Specification of Products.	4
IV	**Preliminary and Detailed Design:** Design Review Preliminary design-Identification of subsystems, Subsystem specifications, Compatibility, Detailed design of subsystems, component design,	6
	Preparation of assembly drawings, Review of product design from point of view of Manufacturing, Ergonomics and aesthetics.	2
V	**Management of New Product:** Development and Launch New Product Management's Challenges, Maintaining focus, Promotion of Right Culture, Management of Creativity, Top Management attention, Design Team Staffing and Organization, Setting key mile stone, Identification of Risk Areas, Project Execution and Evaluation Product Launch Strategies,	8
	TOTAL	**40**

TEXT BOOK		
1	Product Design and Manufacturing, Chitale and Gupta. McGraw Hill.	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Product Design and Development, Ulrich and Eppinger, McGraw Hill	**2003**
2	Project Management in New Product Development, Barkley B.T., Tata McGraw Hill.	**2008**
3	Product Management, Anandan C., McGraw Hill.	**2009**
4	Engineering Design Methods, Cross, Nigel, John Wiley and Sons.	**1995**
5	Product Design and Manufacture, Lindbeck, J.R., Prentice Hall of India.	**1995**

Course outcome

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

CO1: Explain the process of product development.

CO2: Analyse the need for a product and its economic existence.

CO3: Select a concept or product through feasibility study of different identified

solution.

CO4: Prepare the specifications and detailed design of components considering manufacturing aspects ,ergonomics and aesthetics.

CO5: Define new product management and launch strategies.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1 PSO2
CO1	1	1	3	2	1	2	2		1			
CO2	1	2	3	2	1	2	2		1	1		
CO3	1	3	3	2	2	2	2		1	1		
CO4	2	3	3	2	1	2	1		1			
CO5	2	1	1	1	1	2			2		3	
Average	**1.4**	**2.0**	**2.6**	**1.8**	**1.2**	**2.0**	**1.8**		**1.2**	**1.0**	**3.0**	

8PIU2.2: MECHATRONICS AND MEMS

B.Tech. (P&I) 8th semester
3L+1T

Unit	CONTENTS	Contact Hours
I	**Overview of Mechatronics**: Historical perspective, Definition, Applications, Block diagram of Mechatronic system, Functions of Mechatronics Systems, Systems Engineering, Verification Vs Validation, Benefits of mechatronics in manufacturing	2
	Electrical and Electronic Systems: Electrical circuits and Kirchhoff's laws, Network Theorems and AC circuit Analysis, Transformers, Analog Devices, Signal Conditioning, Digital Electronics, Data Acquisition systems.	3
II	**Modeling, Analysis and Control of Physical Systems:** Basics of System Modeling: LTI and LTV systems, Need for modeling, Types of modeling, Steps in modeling, Building blocks of models, Modelling of one and two degrees of freedom systems, Modeling of Electro-mechanical systems, Mechanical Systems, Fluid systems, Thermal systems; Dynamic Responses, System Transfer Functions, State Space Analysis and System Properties, Stability Analysis using Root Locus Method, Stability Analysis using Bode Plots, PID Controllers (with and without Time Delay)	3
III	**Sensors and Actuators**: Static characteristics of sensors and actuators, Position, Displacement and Proximity Sensors, Force and torque sensors, Pressure sensors, Flow sensors, Temperature sensors, Acceleration sensors, Level sensors, Light sensors, Smart material sensors, Micro and Nano sensors, Selection criteria for sensors, Actuators: Electrical Actuators (Solenoids, Relays, Diodes, Thyristors, Triacs, BJT, FET, DC motor, Servo motor, BLDC motor, AC motor, Stepper motors), Hydraulic and Pneumatic actuators, Design of Hydraulic and Pneumatic circuits, Piezoelectric actuators, Shape memory alloys.	4
IV	**Microprocessors, Microcontrollers and Programmable Logic Controllers**: Logic Concepts and Design, System Interfaces, Communication and Computer Networks, Fault Analysis in Mechatronic Systems, Synchronous and Asynchronous Sequential Systems, Architecture, Microcontrollers, Programmable Logic Controllers (PLCs): Architecture, Number Systems Basics of PLC Programming, Logics, Timers and Counters, Application on real time industrial automation systems.	5
V	**Micro-Electro Mechanical Systems (MEMS):**History, Effect of scaling, Fabrication techniques: Oxidation, Sputter disposition, CVD, Lithography, Etching, Wafer bonding, LIGA, DRIE, Applications: Lab on chip	5
	Case Studies: Design of pick and place robot, Car engine management system, Automated manufacturing system, Automatic camera, Automatic parking system, Safety devices and systems.	3
	TOTAL	**40**

TEXT BOOK		**Ed.**
1	W.Bolton,Mechatronics,Electroniccontrolsystemsinmechanicalandelectricalengineering,PearsonEducation,5/e,2011.	2004
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub Year .**
2	JamesJAllen,MicroElectroMechanicalSystemsDesign,CRCPress.	2013
3	DavidG.AlcaiatoreandMichelB.Histand,IntroductiontoMechatronicsandMeasuringSystems,Mc.GrawHillInt.Edition,3/e,	2006
4	CraigK.C.andStolfi,F.R.,IntroductiontoMechatronicSystemDesignwithApplications,IEEEEducationalActivitiesDepartment,.	1994
5	RobertH.Bishop.TheMechatronicsHandbook, CRCPress,2/e	2007

Course outcome

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

CO1: Discuss overview of mechatronics and MEMS with their applications.

CO2: Classify different sensors and actuators .

CO3: Construct control on mechatronics system.

CO4: Apply signal conditioning and discuss data acquisition system.

CO5: Develop various mechatronics system .

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1	PSO2
CO1	3	3	2	2	1	1		1					
CO2	3	2	1	1									
CO3	3	2	2	2									
CO4	3	2	2	2									
CO5	3	3	3	3	2		1		1				1
Average	**3.0**	**2.4**	**2.0**	**2.0**	**1.5**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**			

8PIU3.1: NON DESTRUCTIVE EVALUATION AND TESTING

B.Tech. (P&I) 8th semester
3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	**Introduction**: An Overview, Factors influencing the Reliability of NDE, Defects in materials, Defects in composites. NDT methods used for evaluation of materials and composites.	3
	Visual Inspection: Basic Principle and Applications.	2
	Liquid Penetrant Testing: Principle, Procedure and Test Parameters, Materials, Limitations and Applications.	3
II	**Radiographic Inspection:** Principles of X – ray radiography, equipment, Absorption, Scattering, X-ray film processing, General radiographic procedures, Reading and Interpretation of Radiographs, Industrial radiographic practice, Limitations and Applications, Welding defects detection. Gamma ray radiography.	8
III	**Ultrasonic Testing:** Principle of wave propagation, Ultrasonic equipment, Variables affecting an ultrasound test, Basic methods: Pulse Echo and Through Transmission, Types of scanning.	5
	Applications of UT: Testing of products, Welding Inspection, Tube Inspection, Thickness Measurement, Elastic Constant Determination, Ultrasonic testing of composites.	3
IV	**Magnetic Particle Inspection:** Methods of generating magnetic field, Demagnetization of materials, Magnetic particle test: Principle, Test Equipment and Procedure, Interpretation and evaluation.	5
	Introduction to Accostic Emission Testing and Thermography.	3
V	**Eddy Current Testing:** Principle of eddy current, Factors affecting eddy currents, Test system and test arrangement, Standardization and calibration, Application and effectiveness.	5
	Comparison and Selection of NDT Methods, Codes and Standards	3
	TOTAL	40

TEXT BOOK		
1	Baldev Raj, T. Jay Kumar, M. Thavasimuthu,Practical Non-Destructive Testing, Narosa.	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Loius Cartz, Non Destructive Testing, ASM International	1995
2	J PRASAD, C G K NAIR, NDT & Evaluation Of Materials, TMH	2008
3	R. Halmshaw, Introduction to the Non-Destructive Testing of Welded Joints,	1997
4	American Metals Society, Non-Destructive Examination and Quality Control, Metals Hand Book, Vol.17, 9th Ed.	1989

8PIU3.2: FUEL CELL AND HYBRID ENGINE TECHNOLOGY

B.Tech. (P&I) 8th semester

UNIT	CONTENTS	CONTACT HOURS
I	Introduction and types of Fuel cell: Introduction : the rational behind fuel cell development, basic principle of fuel cell, operational of fuel cell, efficiency of fuel cell, co generation of heat and power, important reaction such as hydrogen oxidation, methonal oxidation etc	3
	Types of fuel cell: DMFC (direct methanol fuel cell),PAFC (phosphoric acid fuel cells), MCFC (molten carbonate fuel cells), SOFC (solid oxide fuel cells)	4
II	Fuel processing and application of fuel cells: Fuel processing- general, producing hydrogen from alcohol, producing hydrogen from hydrocarbon, hydrogen from other sources, Gas cleanup, reformer system, hydrogen storage system Engineering	6
III	fuel cell engineering, vehicle cell design, stack engineering fuel processing system application: stationary power, propulsion of vehicle, portable application	4
	Electric Vehicle: Introduction, working. Electric car motors, electric car batteries, charging system of electric car, magna charge system. conversion system for transmission.	6
IV	Hybrid vehicle: Introduction, working. Power split devices. Hybrid car performance, gasoline hybrid structure. Gasoline Vs electric power	6
	Transmission components of hybrid vehicle. Advantage and limitation. Different types of hybrid vehicle.	4
V	Solar Vehicles: Introduction and working, photovoltaic cell, solar cell. Energy lose in solar cell. Solar powering house. Solar cost, anatomy of solar cells	7
	TOTAL	40

TEXT BOOK		
1	Electric and Hybrid Vehicles: Design Fundamentals, Second Edition, By Iqbal Husain, CRC press	2009
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Fuel cell technology, N. Sammes, Springer	2012
2	Microbial Fuel Cell, Bruce E. Logan , Willey publication	2008
3	Principle of Fuel Cell, Xiangeo Li, CRC Press	2006
4	Hydrogen fuel cells for road vehicles, corbo et.al, springers	2007
5	Electrical vehicle technology, James laraminie, Wiley	2008

8PIU13: SEMINAR

Course outcome

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

CO1: Review of recent industrial developments and scientific innovations.

CO2: compile informations from different sources in comprehensive manner

CO3: prepare technical report

CO4: present the identified development/innovations

CO5:

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1
	PSO1	PSO2										
CO1	1	3	1				1	1	3	1		3
CO2	1	1							3	3		1
CO3	1	1					1	1	3	3		2
CO4	1	1			2				3	3		1
Average	**1.0**		**1.5**	**1.0**	**2.0**	**1.0**	**1.0**	**3.0**	**2.5**		**1.8**	

8PIU14: PROJECT STAGE -II

Course outcome

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

CO1: Arrange necessary resources and prepare project plans

CO2: Develop the required product/solution considering technical/financial viability

CO3: Test and validate the solutions based on experiment and field trials

CO4: Prepare project report and present results/solution

CO5:

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1
	PSO1	PSO2										
CO1	1					1	2	1	2	2	3	3
CO2	2	2	3	1	2		1	1	3	2	2	3
CO3	2	2	1	3	2		1	1	3	2	1	3
CO4	2		1	1	1			1	2	3	1	3
Average	**1.8**	**2.0**	**1.7**	**1.7**	**1.7**	**1.0**	**1.3**	**1.0**	**2.5**	**2.3**	**1.8**	**3.0**

8PIU20: DISCIPLINE AND EXTRA CURRICULAR ACTIVITIES

Course outcome

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

CO1: Recognize their strength and those of others to work towards a shared vision (leadership)

CO2: Develop and sustain healthy and meaningful relationship with others (Interpersonal skills)

CO3: Identify and address the needs of the community collaboratively to facilitate positive social change (Social Responsibility)

CO4: Generate innovations through experimentation with novel ideas, forms, and methods (Critical and creative thinking)

CO5: Act as a disciplined citizen with ethical and moral values

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1
	PSO1	PSO2										
CO1						2	1	3	2	1		2
CO2						2	1	2	3	3		1
CO3						3	2	2	2	2		2
CO4	3	2	2	2	2		1		2	1		2
CO5						2	1	3	1	1		2
Average	**3.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.3**	**1.2**	**2.5**	**2.0**	**1.6**		**1.8**