Title of the Course: ENGINEERING MATHEMATICS-III	L	T	P	Credits
Course Code: UPRD0301	3	1	---	4

Course Pre-Requisite: Basic terminologies of differential equations, vector algebra, concepts of probability, rules and formulae of integration

Course Description: This Course contains linear differential equations, vector calculus, Laplace transform, statistics and probability.

Course Objectives:

1. To develop abstract, logical and critical thinking and the ability to reflect critically upon their work.
2. To study various mathematical tools like differential equations, integral transforms, vector calculus, probability and statistics to devise engineering solutions for given situations.
3. The student must be able to formulate a mathematical model of a real life and engineering problem, solve and interpret the solution in real world.

Course Outcomes:

COs	After the completion of the course the student will be able to	Bloom's Cognitive level	Descriptor
CO1	Illustrate method of least squares to fit the curves for given bivariate data and find coefficient of correlation.	II	Understanding
CO2	Solve linear differential equations with constants coefficients.	III	Applying
CO3	Make use of appropriate probability distribution for finding probabilities of events.	III	Applying
CO4	Find Laplace transforms of given functions and use it to solve LDEs.	III	Applying
CO5	Form mathematical model for mass-spring mechanical system, whirling shafts, solve and interpret the result.	IV	Evaluating
CO6	Apply knowledge of vector differentiation to find directional derivatives curl and divergence of vector fields.	IV	Evaluating

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	2		2								1		
CO2	3	2										1		
CO3	3	2		2								1		
CO4	3	2										1		
CO5	3	3										1		
CO6	3	2										1		

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10

MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three units)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three units) covered after MSE.

Course Contents:

Unit 1: Linear Differential Equations with Constant Coefficients Definition, general form, complete solution 1.1 Rules for finding complementary function 1.2 Short methods for finding particular integral 1.3 General Rule for finding particular integral 1.4 Cauchy's homogeneous linear differential equation	8 **Hrs.**
Unit 2: Applications of Linear Differential Equations with Constant Coefficients 2.1 Mass – spring Mechanical system 2.1.1 Free oscillations 2.1.2 Damped Oscillations 2.1.3 Forced oscillations without damping. 2.2 Whirling Shafts	6 **Hrs.**
Unit 3: Statistical Techniques 3.1 Correlation and Coefficient of correlation 3.2 Lines of regression of bivariate data 3.3 Fitting of curves by method of least-squares 3.3.1 Fitting of straight lines 3.3.2 Fitting of exponential curves.	7 **Hrs.**
Unit 4: Probability Distributions 4.1 Random variable 4.2 Probability mass function and probability density function 4.3 Binomial distribution 4.4 Poisson distribution 4.5 Normal distribution	6 **Hrs.**
Unit 5: Vector Differential Calculus 5.1 Differentiation of vectors 5.2 Velocity and acceleration 5.3 Gradient of scalar point function and Directional derivative 5.4 Divergence of vector point function 5.5 Curl of a vector point function 5.6 Solenoidal and Irrotational vector fields	8 **Hrs.**
Unit 6: Laplace Transform 6.1 Definition, transforms of elementary functions, properties of Laplace transform 6.2 Transforms of derivative and integral 6.3 Inverse Laplace transform 6.4 Inverse Laplace transforms by using partial fractions and convolution theorem. 6.5 Solution of linear differential equations with constant coefficients by Laplace transform method.	7 **Hrs.**

Recommended Books:

1. Higher Engineering Mathematics by Dr. B. S. Grewal, Khanna Publishers, Delhi.
2. A Text Book of Applied Mathematics, Vol. I, Vol. II and vol. III by P. N. Wartikar & J. N. Wartikar, Pune Vidyarthi Griha Prakashan, Pune.

Reference Books:

1. Advanced Engineering Mathematics by Erwin Kreyszig, Wiley India Pvt. Ltd.
2. Advanced Engineering Mathematics by H. K. Dass, S. Chand, New Delhi.
3. A text book of Engineering Mathematics by N. P. Bali, Iyengar, Laxmi Publications (P) Ltd., New Delhi.
4. Mathematics for Engineers Vol-I & Vol-II by Rakesh Dube, Narosa Publishing House.

Unit wise Measurable Learning Outcomes:

Unit 1: Linear Differential Equations with Constant Coefficients and Its Applications

Students will be able to

a) Solve linear differential equations with constant coefficients.
b) Solve Cauchy's homogeneous linear differential equation

Unit 2: Applications of Linear Differential Equations with Constant Coefficients

Students will be able to

a) Solve the problems on free oscillation, damped oscillation and forced vibrations.
b) Solve the problems on whirling shafts.

Unit 3: Statistical Techniques

Students will be able to

a) Compute coefficient of correlation for given data.
b) Find lines of regression for the given bivariate data.
c) Fit straight lines, exponential curves for given data.

Unit 4: Probability Distributions

Students will be able to

a) Verify the function as probability mass and density function.
b) Use probability distributions in solving physical and engineering problems.

Unit 5: Vector Differential Calculus

Students are able to

a) Differentiate vector quantity.
b) Find the directional derivative of scalar point function.
c) Find the divergence and curl of vector point function.
d) Determine solenoidal and irrotational fields with the help of divergence and curl respectively.

Unit 6: Laplace Transform

Students are able to

a) Find Laplace transform by using definition
b) Recall properties of Laplace transform and use to find transforms of given functions.
c) Use Laplace transform method to solve linear differential equations.

Title of the Course: Foundry Technology **Course Code: UPRD0302**	**L**	**T**	**P**	**Credit**
	3	**-**	**-**	**3**

Course Pre-Requisite:

Fundamental knowledge materials and basic metal forming techniques.

Course Description:

Casting is the process from which solid metal shapes (castings) are produced by filling voids in molds with liquid metal. The basic steps involved in making castings are patternmaking, molding, melting and pouring, shakeout and cleaning, heat treating, and inspection. Casting is a defect prone manufacturing process. Hence Casting simulation helps to visualize mold filling and casting solidification; to predict sand casting defects.

Course Objectives

- To understand the basic casting process, sequence of operations to be followed through design of pattern and design of gating system.
- To gain fundamental knowledge of various traditional and special casting processes.
- To understand cause and effect of various defects in casting.
- To understand optimizing yield though use of casting simulation software's

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	**List** sequence of operations to be followed in a metal casting process in converting raw material in to a finished product.	I	Knowledge
CO2	**Demonstrate** a sand casting process.	II	Skill
CO3	**Model** pattern layout by utilizing knowledge of CAD.	III	Knowledge
CO4	**Experiment with** mold filling simulation on online simulation tools for predicting defects.	III	Knowledge
CO5	To **demonstrate** a melting and pouring practice with available resources.	III	Knowledge
CO6	**Categorize** between various sand/die casting defects by carrying out cause and effect analysis.	IV	Knowledge

CO-PO Mapping:

CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	**2**											
CO2	**3**											
CO3			**2**		**3**							
CO4			**2**		**3**							
CO5	**2**											
CO6				**2**								

Assessments :

Teacher Assessment:
Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30

ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/Moodle quiz/Topic seminar/Group Discussions, Industrial case study etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1: Introduction to Overview of metal casing technology:	2**Hrs.**

Importance and role of casting process as a manufacturing process in industry, Advantages and limitations of casting process, Classification of foundries , Flow chart describing foundry activities, Introduction to different ferrous and non-ferrous cast alloys and their applications

Unit 2: Introduction to foundry tooling	**04Hrs.**

Patterns, core boxes and dies,Types of patterns, Pattern Material, pattern making Tools ,Criteria for pattern material selection, Functions of patterns, pattern design considerations , patterns layout, core boxe and dies, Application of allowances and selection of parting line, Use CAD- CAM in Designing and manufacturing of patterns and Dies, Use of 3D printing as foundry tooling

Unit 3: Gating and risering system, sand conditioning	**09Hrs.**

Gating System- types of Gates and Risers, Gating Ratios and chills, Feeder location & design in actual casting, Directional Solidification in Casting, Casting Yield, Feedaids, Physical Behavior of Metals during Solidification. Use of simulation software for designing, optimization of gating, risering.
Introduction to Moulding Sand – Types and Properties, Moulding Tools and Equipments- Moulding Machines and Hand Moulding tools, Function of Core, Types of Cores, Core Prints, Core Venting and Baking, Core Shifting and Chaplets, Traditional and Modern Moulding Processes viz Bench Moulding, Floor Moulding, Pit Moulding, Stack Moulding, Green Sand Moulding, Dry Sand Moulding, Loam Moulding, Core Moulding, Machine Moulding. High pressure line, magnetic molding, vacuum "V" molding process, molding. Case studies in optimization of gating system using simulation tools

Unit 4: Special casting technology	**5Hrs.**

Investment casting, full mold casting, ceramic castings, shell casting, Squeeze casting, thixocasting, vaccume casting, slush casting, Centrifugal casting and Die casting rocess and application, HPDC, LPDC,

Unit 5: Melting technology	**8Hrs.**

Furnace, Types , Cupola: Constructiona Working of Cupola, Lining Material, Raw Material For Melting, Charge Calculations, Latest Designs and Modifications in Cupola Melting, Construction, Working, Applications of Rotary Furnaces, Oil Fired Furnaces, Electric Furnaces– Induction and Arc Furnaces ,Selection Parameters for Furnaces, Composition, Physical Properties and Applications of Ferrous and Non-Ferrous Castings – Grey Cast Iron, S. G. Iron, White Cast Iron, Malleable Cast Iron and Non ferrous alloys as Brass, Bronze , Importance & Methods Of Inoculation In Cast Irons. Degassing And Modification Treatments In Aluminum Alloy Castings. Ladles – Types, Advancement in Lining Materials., Composition Tests – CE Meter, Wedge Test, Fluidity Test, Spectrometers, temperature Tests – Pyrometers, Maintanance and Energy Saving Concepts.

Unit 6: Post melting operations	**8 Hrs.**

Fettling and cleaning of castings, Shot blasting, using pneumatic chippers and grinders,Salvaging , Heat treatment and painting of castings, Defects, inspection and testing of castings,NDT-Visual,Dye penetrant, Ultrasonic,Xray radiography, Magnetic particle inspection, Casting defects cause – effect and remedies , Fish bone diagram, Casting rejection analysis, Safety aspects in foundries, Environmental issues and regulations, Possible hazards in foundries, Safety measures, Safety devices, Foundry mechanization and automation, Automatic Ladle System, industrial safety

Textbooks:

1. Manufacturing Technology: Foundry, Forming & Welding by P. N. Rao (TMH)
2. Metal Casting – Principles & Practice by T. V. Rama Rao (New Age International Pvt. Ltd.)

3. A Text Book on Foundry Technology by M. Lal, O. P. Khanna(Dhanpat Rai & Co.)
4. A Course on Workshop Technology – Vol. 1 by B. S. Raghuvanshi; (Dhanpat Rai & Co.)
5. Fundamentals of Metal Casting by P. C. Mukharjee (Oxford & IBH Publishing Co).
6. Principles of Foundry Technology by P. L. Jain (Tata McGraw Hill)
7. Foundry Practice by N. D. Titov (MIR)
8. Foundry Engineering by Taylor, Flemings, Wulff (Wiley Eastern Ltd.)
9. Principles of Metal Casting by Heine, Loper, Rosenthal

References:

1. Casting Technology And Casting Alloys by A.K.Chakrabarti, (PHL Learning Pvt Ltd.)
2. Iron and steel making by Ahindra Ghosh, Amit Chatterjee (PHL Learning Pvt Ltd.)
3. Complete Casting Handbook-Metal Casting Processes, Metallurgy, Techniques & Design by John Campbell (BH Publication
4. Casting simulation website www.efoundryiitb.ac.in
5. The FOSECO Foundry man's handbook 10th edition by Butter Worth-Heinemann (BH Publication)
6. ASM Handbook Volume 15 on casting

Unit wise Measurable students Learning Outcomes:

Unit 1	Overview of metal casing Technology:	ULO1.1: To select casting as a production process in a process plan ULO1.2: To differentiate between ferrous and non ferrous alloys.
Unit 2	Introduction to foundry tooling	ULO2.1: To select proper pattern material as per requirement and design and prepare pattern/core box with CAD design. ULO2.2: To use different wood working tools in making pattern
Unit *3*	Gating and risering system, sand conditioning	ULO 3.1: To optimize gating and risering system by using CAD and online E tools. ULO3.2: To measure various sand properties by carrying out sand tests. ULO3.3: To design an gating and risering system ULO3.4: To use different methods of improving casting Yield
Unit 4	Sand Molding, core making:	ULO4.1: To select a proper molding process. ULO4.2: To learn different advanced molding and casting processes
Unit 5	Melting technology	ULO 5.1: Students should be able to select a proper furnace as per given condition. ULO 5.2: To carry out different tests prior to pouring on molten metal
Unit 6	Post melting operations	ULO 6.1: Students should be able to identify a type of defect and will be able to suggest proper remedies. ULO 6.2: To select a definite type of HT process cycle as per material and requirements.

Course Name: **Foundry Technology (Theory)**

Course Code: UPRD0302

Problem Statements:

FTPBLPB01: Optimization of sand cast process: An industry case study

"The industry located in MIDC area, Kolhapur is facing the serious problem of defining optimized casting process. Due to undefined process the industry is facing economical loss which needs to be reduced. How you can help the industry to optimize the sand casting process which can increase their economical loss?"

FTPBLPB02: Suggestion for reduction of casting defects such as cold shut and oversize

"The foundry located in MIDC area, Kolhapur is facing the problem of casting defect such cold shut and oversize. These defects are observed frequently which results in rejection of components. How you can help the industry to reduce these defects which can reduce the rejection of the component?"

FTPBLPB03: Suggestion for reduction of casting defects such as fins, slag inclusion, mismatch and shrinkage

"The foundry located in MIDC area, Kolhapur is facing the problem of casting defect such fins, slag inclusion, mismatch and shrinkage. These defects are observed frequently which results in rejection of components. How you can help the industry to reduce these defects which can reduce the rejection of the component?"

FTPBLPB04: Modeling and drafting of casting layout by using pattern drawing which include gating system

"The Kolhapur is well known as the cluster for foundry. These foundry industries are following the ancient techniques for drawing the casting layouts which needs to be updated by the latest technology such as CAD. Demonstrate the modeling and drafting of the any industry component including design of gating system"

FTPBLPB05: Optimization of material handling system: An industry case study

"The industry located in MIDC area, Kolhapur is facing the serious problem of material handling required for sand casting process. The optimization of material handling can boost the production rate. How you can help to optimize the material handling system in industry for sand casting process?"

FTPBLPB06: Suggestion for reduction of casting defects such as pinholes and surface roughness

"The foundry located in MIDC area, Kolhapur is facing the problem of casting defect such pinholes and surface roughness. These defects are observed frequently which results in rejection of components. How you can help the industry to reduce these defects which can reduce the rejection of the component?"

FTPBLPB07: Demonstration of casting process (prototype of component manufacture from wax)

"The industry located in MIDC area, Kolhapur is facing the serious problem of defining optimized casting process. Due to undefined process and lack of experience the industry is facing economical loss which needs to be reduced. Demonstrate the casting process to gain the hands-on experience of sand casting process."

FTPBLPB08: Numerical simulation for the prediction of defects in sand casting process

"The Kolhapur is well known as the cluster for foundry. These foundry industries are following the ancient techniques for prediction of sand casting process which needs to be updated by the latest technology such as finite element analysis. Demonstrate the FEA simulation for the prediction of defects in sand casting process"

2. Activities with timeline:

Sr. No.	Activity	Timeline
1	PBL awareness in class	1st week
2	Announcement of problem/s for PBL	2nd week
3	Team formation	3rd week
4	Project ISE I:Synopsis presentation	5th week
5	Completion of corrections/improvements in synopsis	6th week
6	Project ISE II: Project Progress Presentation with Model/case study	10th week
7	Completion of correction/improvements in Evaluation II	11th week
8	End Semester Evaluation of Project	13th week
9	Determining future scope for improvement	14th week

3. Assessment Scheme:

- ISE-I
- ISE-II
- Project ESE

4. Evaluation Scheme:

- **Project ISE I :** Synopsis presentation for 5 marks (evaluation with rubrics)
- **Project ISE II:** Project Progress Presentation with Model/case study for 5 marks (evaluation with rubric)
- **End Semester Evaluation of Project:** Multimedia presentation and demonstration of working models for 15 marks out of 25 of course lab ISE (evaluation with rubrics)

Title of the Course: Machine Tools and Processes	L	T	P	Credit
Course Code: UPRD0303	3	1	-	4

Course Pre-Requisite: operations performed on various machines

Course Description: This course aims to impart knowledge of machine tools and operations performed on to it, different movements required to process the component from raw material into finished product.

Course Objectives:

1) To understand the various conventional and basic machine tools and manufacturing processes carried out on these machines for different applications.
2) To gain the basic knowledge about machine tools and its construction and principles of working.
3) To study different parts of the machine tools used in manufacturing machine shops.
4) To study the detailed assembly of manufacturing machine tools.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		level	Descriptor
CO1	The student shall be able to differentiate between metal cutting process and metal forming process.	1	Understanding
CO2	The student shall be able use various systems of machine tool.	2	Applying
CO3	The student shall be able to identify machine tools for various operations performed on components.	4	Applying
CO4	The student shall be able to select machine tool or process for simple applications	5	Applying

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2		1	1		1	1	1	2				1	
CO2	2		2	1		1	1	1	2				1	2
CO3	2	2	2	1		1	1	1		1			2	
CO4	2	2	1	2	1	1	1	1	2	1		1		2

Assessments :

Teacher Assessment:√

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1: Lathe : Specification, types of lathe; different parts, Apron mechanism; operations on lathe, accessories and attachments, lathe tools, machining time calculation for turning.	**8 Hrs.**
Unit 2: Shaping & Planning Machine: Different elements of shaping & planning machines; specification. shaper drive, feed mechanism, work holding devices, different machining operations in shaper & planer: flat	**5 Hrs.**

surfaces, slot cutting, grooving, T- slot, dovetail, machining time calculation, shaping and planning tools, difference between planer & shaper. **Slotting Machine:** specification of slotter, slotting drive	
Unit 3: Drilling Machine: specification, classification of drilling machine; work and tool holding devices, different machining operations in drilling, nomenclature of drill, reamer, machining time calculation, center drilling, **Boring machine:** specifications, Types of boring machines, different operations, boring bar and head	**5 Hrs.**
Unit 4: Milling Machine: Introduction, Classification, Principal parts of column and knee type milling machine and vertical milling machine, work holding devices, Milling machine attachments, Milling cutters types, fundamentals of the Milling process- Up milling and down milling, Milling operation concepts, Indexing- Direct, Simple, Compound, Differential and Angular indexing, calculations, problems, machining time calculations	**8 Hrs.**
Unit 5: Gear Manufacturing: Gear shaper, hobbing and gear finishing processes Broaching: Construction and working of horizontal, vertical pull type and push type Broaching machine, Use of broach head and fixtures.	**4Hrs.**
Unit 6: Grinding Machine: specification of grinding wheel; different types of grinding processes:-surface, cylindrical & internal grinding, tool & cutter grinding; wheel mounting, wheel dressing, wheel truing, wheel balancing, machining time calculation	**6 Hrs.**

Textbooks:

1. Workshop Technology by Hajra Choudhry, Vol-II, Media promoters and Publishers Pvt. Ltd., 2nd editon,2010
2. Production technology by HMT, Tata McGraw Hill, 2004.
3. Workshop Technology Vol. II by Bawa H. S. (TMH)
4. Manufacturing Technology – Metal Cutting & Machine Tools by P. N. Rao (TMH)
5. A course in Workshop Technology, Vol – 2, B S Raghuwanshi, Dhanpatrai & Co.

References:

1. Manufacturing Science – Amitabha Ghosh and Mallik, Affiliated East West press, 2010, 2nd edition.
2. Modern machining Process – Pandey and Shah, Tata Mc Graw Hill – 2009.
3. Manufacturing processes for Engineering Materials by Serope kalpakijian and Steven R.Schimid pearson education 2009, 5th edition.
4. Materials and Processes in Manufacturing by E.Paul DeGarmo, J T Black, Ronald A Kohser, 8th Edition, Prentice Hall of India Private limited, 2004.

Unit wise Measurable students Learning Outcomes:

1.After completion of units , students are able to:

2.Understand the metal cutting process, types of conventional machine tools used in industry, different parts of machine tools, various operations to be performed on selected machine tool.

Title of the Course: Thermal Engineering	**L**	**T**	**P**	**Credit**
Course Code: UPRD0304	**3**	**-**	**-**	**3**
Course Pre-Requisite: Basic Physics, Chemistry, Basic Mechanical Engg				
Course Description: Basic Concepts in Thermodynamics, Laws of Thermodynamics and applications, Second Law of Thermodynamics, Modes and laws of heat transfer, Various				

systems of I. C. Engine, Concepts of Compressor, Refrigeration and Air Conditioning.

Course Objectives:

1. To Understand various Laws of Thermodynamics and its applications in thermodynamic systems.
2. Study steam properties, Interpret steam tables and Mollier charts with numerical applications.
3. To Understand the Modes and laws of heat transfer.
4. Know various systems of I. C. Engine.
5. To understand the basic concepts of air compressors.
6. To get acquainted with the basic principles of refrigeration and air-conditioning.

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Explain fundamentals of thermal engineering.	II	Understanding
CO2	Explain working of thermal devices.	II	Understanding
CO3	Make use of steam table and Mollier Chart.	III	Applying
CO4	Solve for performance parameters of various thermal devices.	III	Applying

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2		3												
CO3		2												
CO4		3											2	

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:- **Thermodynamics** Basics of Thermodynamics, First Law of Thermodynamics, Steady Flow Energy Equation, Carnot Cycle, Second Law of Thermodynamics, Concept of refrigeration,	**6 Hrs.**

Heat Pump and Heat Engine, Equivalence of the two statements, Reversible and irreversible process.	
Unit 2:--- **Vapour Power Cycles** Properties of steam, Ideal Rankine Cycle, Thermal efficiency, Methods to improve Rankine efficiency, Numerical using Steam table and Mollier Chart. **Turbines and Condensers** Introduction to steam turbine, Types, Compounding Introduction to condensers, Types.	**6 Hrs.**
Unit 3:--- **Heat Transfer** Application areas of heat transfer in manufacturing and machine tools, Modes and laws of heat transfer, steady state heat conduction, thermal resistance, Insulating materials, Heat Exchangers - Classification and Types	**6 Hrs.**
Unit 4:--- **Internal Combustion Engines** Air standard Otto, Diesel cycles, classifications of systems of I.C. engines such as fuel supply system for SI & CI engines, ignition system, cooling system, lubrication system, Performance of IC Engine – Indicated power, Brake power, Thermal efficiency, Specific fuel consumption, Heat balance.	**8 Hrs.**
Unit 5:- **Reciprocating Air Compressors** Applications of compressed air, Classification of air compressors, Work and power calculations with and without clearance for single and two stage compression, Volumetric efficiency and FAD, Intercooling and advantages of Multistage compression.	**7 Hrs.**
Unit 6:--- **Refrigeration and Air conditioning** Applications of refrigeration, Reversed Carnot Cycle, Bell Coleman Cycle, Analysis of Simple Vapour Compression Cycle, Representation on T-s and p-h diagrams, COP and power calculations, Introduction to Vapour Absorption Cycle, Types and properties of refrigerants, Eco-friendly refrigerants, Psychrometry - basic concepts, terms and processes Summer, Winter and Industrial Air conditioning Systems.	**7 Hrs.**
Textbooks: 1. Basic and Applied Thermodynamics, 2nd Edition, Nag P. K., Tata McGraw-Hill. 2. Thermodynamics: An Engineering Approach, 3rd Edition, Yunus Çengel and Michael, Boles, Tata McGraw Hill. 3. Yunus A Cengel, Heat transfer -A Practical Approach, McGraw Hill Publication. 4. Mathur and Sharma, Internal Combustion Engines, Dhanpat Rai and Co.	
References: 1. Sonntag, R. E., Borgnakke, C., & Wylen, G. J. V. Fundamentals of thermodynamics: Wiley. 2. Moran, M. J., Shapiro, H. N., Boettner, D. D., & Bailey, M. Fundamentals of	

Engineering Thermodynamics.
3. V Ganeshan, Internal Combustion Engines, McGraw-Hill.
4. David P. Dewitt, Theodore L. Bergman, Adrienne S. Lavine Frank P. Incropera , Principles of Heat and Mass Transfer, Wiley; Seventh edition (2013)

Unit wise Measurable students Learning Outcomes:

After completion of unit , students are able to

1. Explain fundamental of Thermodynamics.
2. Use Mollier chart and steam table
3. Explain fundamentals of Heat Transfer.
4. Solve Numericals on I. C. Engine
5. Solve Numericals on Reciprocating Compressor
6. Solve Numericals on C.O.P. of refrigeration.

Title of the Course: Industrial Electronics & Electrical Drives Course Code:UPRD0305	L	T	P	Credit
	03	-	-	3

Course Pre-Requisite:

Course Description:

Course Objectives:

1. To learn the theoretical concepts governing the electric motors useful in the field of production engineering.
2. To study various electrical machines and their applications in Production Engineering
3. To study various electronics devices such as power control devices, integrated circuits and its industrial applications.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Make use of electric motors according to the requirement in production engineering area.	III	Applying
CO2	Demonstrate the control of electric motors	II	Understanding
C03	Understand speed-torque characteristics of electrical machines for implementation of speed control methods using electrical drives.	I	Understanding
CO4	Demonstrate the knowledge of basic functioning of digital circuits and microcontrollers	II	Understanding

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	-	-	2	2	2	-	-	-	2	-	-	-	-
CO2	-	-	2	2	2	-	-	-	2	-	-	-	-
CO3	-	-	2	2	2	-	-	-	2	-	-	-	-
CO4	-	-	2	2	2	-	-	-	2	-	-	-	-

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:	
Unit 1 D C Motor: Construction, working, types, equivalent circuit, back emf, speed equation, torque equation, speed torque characteristics, power losses, applications, Need of starter, 3 point starter, 4 point starter, reversal of rotation, Electric braking, DC servo motor - desirable features, types and applications. Stepper motor- desirable features, types and applications.	7**Hrs.**
Unit 2 3 phase AC motor: 3 phase induction motor- Construction, working, types, speed equation, torque equation, speed torque characteristics, power losses, applications, Need of starter, star delta starter, DOL starter, autotransformer starter, rotor resistance starter, reversal of rotation, Electric braking.	7 **Hrs.**
Unit 3 Drives and Control: Benefits of electric drive, individual drive, multi motor drive. Types of mechanical load (Based on speed-torque variation, active/passive load.) Concept of stable operating characteristics of electric motor under load variations. DC motor Speed control – armature control, field control(Numerical treatment), 3 phase induction motor Speed control - voltage control, V/f control, rotor resistance speed control (Numerical treatment) Electrical to mechanical Energy conversion (Numerical Treatment)	7 **Hrs.**
Unit 4 Study of Power Control Devices: SCR, Triac, Power MOSFET, IGBT, characteristics and simple applications like controlled rectifiers. Triggering circuits using Diac/UJT and digital logic: Power supply protection circuits (over voltage, thermal shutdown and current limiting). Study of UPS (only block diagram), light dimmers, fan regulators.	6 **Hrs.**
Unit 5 Integrated Circuits and Applications Amplifiers: Review of Op-amp IC 741, Audio Power Op-Amp ICs like TBA 810, LM 380, Schmidt trigger and its applications, Op-Amp as wave form generator (square and ramp), case study of waveform generator IC such as 8038 or XR 2206. IC 555 as mono-stable and a stable multi vibrator and its applications in Mechanical Engineering. Cascading of Timers, sequential timers. Binary and BCD adder, subtractor. Shift registers, counters, applications of digital circuits such as staircase, traffic light, lift controller, sequential controllers, mechanical system, opto isolators and opto couplers.	8 **Hrs.**
Unit 6 Industrial Applications: Resistance welding, RF heating energy storage welding, ultrasonic method of testing of materials, principles of LASER and applications. DC drives, separately excited and series motors, speed control of AC motors. Use of CR0 as a display device for industrial application. Smoke, temperature, pressure, vibrations, displacement, flow, level detectors. Controllers using these sensors annunciator circuits, electronic weighing systems, electronic ignition systems, proximity switches. Analog to Digital and digital to analog converters. Introduction to PLC, concept to distributed control systems, concept of computerized numerical controllers	8 **Hrs.**
Textbooks: 1. Electrical Technology (Vol. II)- B. L. Theraja ,S. Chand Publ. 2. Utilllization of Electric power- R.K.Rajput, Laxmi Publ. 3. Ramamoorthy: Thyrister and Power Electronics Applications, Prentice Hall of India.	

References:

1. Electrical power – S. L. Uppal, DBS Publication
2. First course in Electrical Drives- Pillai S.K – Willey Eastern
3. Chute & Chute: Electronics in Industry, Tata McGraw Hill.
4. R.P. Jain: Modern Digital Electronics, Tata McGraw Hill.
5. Harish C. Rai: Industrial and Power Electronics (Umesh Publication, Delhi).
6. C. S. Rangan, Sharma, Mahi: Instrumentation, devices and system (WIE).
7. Curtis Johnson: Process Instrumentation, Prentice Hall of India.

Unit wise Measurable students Learning Outcomes (ULO):

1. To learn the theoretical concepts governing the working of dc motor.
2. To learn the theoretical concepts governing the working of 3 phase induction motor.
3. To learn the control of dc motor and 3 phase induction motor.
4. Learn all speed control methods of separately excited and self excited DC motors and AC motor and with solid state control so these can be used as DC drive and AC drives.
5. Understand power control devices like, Triac, SCR, IGBT MOSFET and their triggering methods and design fan regulator and light dimmer circuit.
6. Study and select proper OPAMP mechanical or production application like wave form generators IC555 as a timer ,cascading of timers and sequential timer

Title of the Course: Professional Skill Development Course Code:UORD0361	L	T	P	Credit
	02	-	-	-

Course Pre-Requisite:
Good communication skill
Writing skill

Course Description: The Professional Development course is designed to improve the ability of students to describe their accomplishments and sell their ideas in situations like professional networking, company meetings, response to proposals for services, and interviews.

Course Objectives:

1. Student should able to Communicate effectively in business situations
2. Learn, Practice and improve technical skills
3. Utilize collaborative and management skills in a team context
4. Develop presentation skills Develops ethical Skills
5. Prepare the student for future Engineering positions

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Show technical, ethical and soft skills necessary for workplace success	II	Understanding
CO2	Apply skill of Communication effectively and professionally in business situations through writing, speaking, and listening.	III	Applying
CO3	Develop skills of technical writing and presentation of Research Articles and proposals.	III	Applying
CO4	Develop performance at placement interviews, Group discussions and other recruitment exercises by demonstrating awareness of behavioral norms, communication, appearance, business etiquette, and teamwork.	III	Applying

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	-	-	-	-	-	-	-	2	3	3	-	-	2
CO2	-	-	-	-	-	-	-	2	2	3	-	-	2
CO3	-	-	-	-	-	-	-	-	-	2	-	-	2
CO4	-	-	-	-	-	-	-	-	-	2	-	-	2
CO4	-	-	-	-	-	-	-	2	3	3	-	-	2

Assessments :

Assessment	Marks (Mini. marks for Passing = 40)
ESE	100

Course Contents:

Unit 1 Technical Writing and Business Communication: Informal and formal letter writing ,quotations, purchase orders, enquiry letter, invitation and acceptance letter, notice of meeting ,circular, agenda and minutes of meeting.	2**Hrs.**

Unit 2 Report and Proposal Writing: Different types of report, structure of a report, characteristics of a good report, project report, structure of a general format proposal, importance of a proposal	2 **Hrs.**
Unit 3 The e-English: Writing email to an unknown person, guidelines for continuing the conversation on emails, the top ten Do's, Business emails, marketing emails.	2 **Hrs.**
Unit 4 Team Building and Time Management: Interpersonal skills, what is needed to form smart team. Different approaches to team building. Techniques of a time management: ABC analysis, Pareto analysis, fit analysis, POSEC method, Eisenhower method, Prerequisite of time management.	4 **Hrs.**
Unit 5 Corporate Etiquettes: Business dress and grooming, office etiquettes, telephone etiquettes, dining etiquettes, meeting etiquettes, travel etiquettes	2 **Hrs.**
Unit 6 Writing a Research Article and Mastering Presentation Skills: General form, title page, abstract, methods, results, literature cited, Microsoft office power points creating presentation, formatting, adding Graphics, animation videos.	2 **Hrs.**
Textbooks: 1. "Soft skills for managers",Dr. T. Kalyana Chatravarthi, Dr. T. Latha Chatravarthi Biztantra. 2. "Soft skills for young managers", by Prof. M. S. Rao Wiley India Pvt. Limited..	
References: 1] Dr. M. Hemamalini , "Technical English", Published by Wiley India Pvt.ltd. 2] S. Hariharan, "Soft skills", MJP Publiishers Chennai , (2010).	
Unit wise Measurable students Learning Outcomes: **1** Communicate effectively in business situations **2** Prepare Business proposals and reports **3** develop good communication through effective writing **4** Perform well in campus interviews as a team leader **5** help in organizing placement activities **6** Deliver seminars and engineering articles with effective presentation	

Title of the Course: Foundry Technology Lab Course Code: UPRD0331	L	T	P	Credit
	-	-	2	1

Course Pre-Requisite:

Fundamental knowledge materials and basic metal forming techniques.

Course Description:

Casting is the process from which solid metal shapes (castings) are produced by filling voids in molds with liquid metal. The basic steps involved in making castings are patternmaking, molding, melting and pouring, shakeout and cleaning, heat treating, and inspection. Casting is a defect prone manufacturing process. Hence Casting simulation helps to visualize mold filling and casting solidification; to predict sand casting defects.

Course Objectives

CLO1: To learn the basic casting process, Various metals and alloys with sequence of operations to be followed through design of pattern and gating system.
CLO2: To Gain fundamental knowledge of various traditional and special casting processes.
CLO3: To Categorize cause and effect of various defects in casting.
CLO4: To Understand optimizing yield though use of casting simulation software

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	**List** sequence of operations to be followed in a metal casting process in converting raw material in to a finished product.	I	Knowledge
CO2	**Demonstrate** a sand casting process.	II	Skill
CO3	**Model** pattern layout by utilizing knowledge of CAD.	III	Knowledge
CO4	**Experiment with** mold filling simulation on online simulation tools for predicting defects.	III	Knowledge
CO5	To **demonstrate** a melting and pouring practice with available resources.	III	Knowledge
CO6	**Categorize** between various sand/die casting defects by carrying out cause and effect analysis.	IV	Knowledge

CO-PO Mapping:

CO	1	2	3	4	5	6	7	8	9	10	11	12
CO1	**2**											
CO2	**3**											
CO3			**2**		**3**							
CO4			**2**		**3**							
CO5	**2**											
CO6				**2**								

Assessments :

Teacher Assessment:
One components of In Semester Evaluation (ISE1) and one End Semester Examination (ESE) having 25 marks each

Assessment	Marks (Mini. marks for Passing = 10)

ISE 1	25
ESE (O.E)	25
ISE 1 are based on unit assignment and lab experiment. ESE: Assessment is based Oral examination basedon on 100% course content	
Course Contents:	
Experiment No. 1 **Aim and Objectives**: Determination of grain fineness number of given foundry sand. **Outcomes:** Able to determine grain fineness number of foundry sand and will able to judge its effect on quality of casting **Theoretical Background:** Inherent sand properties, types of sand **Experimentation:** ---------- **Results and Discussions:** ---------- **Conclusion:** ----------	2**Hrs.**
Experiment No. 2 **Aim and Objectives: Determination of percentage of clay content present in given foundry sand.** **Outcomes:** Able to derermine percentage of clay content present in given foundry sand and will able to judge its effect on quality of casting **Theoretical Background:** Inherent sand properties, types of sand **Experimentation:** ---------- **Results and Discussions:** ---------- **Conclusion:** ----------	02**Hrs.**
Experiment No. 3 **Aim and Objectives:** Determination of percentage of Moisture content present in given foundry sand **Outcomes:** Able to derermine percentage of Moisture content present in given foundry sand and will able to judge its effect on quality of casting **Theoretical Background:** Inherent sand properties, types of sand **Experimentation:** ---------- **Results and Discussions:** ---------- **Conclusion:** ----------	02**Hrs.**
Experiment No. 4 **Aim and Objectives:** Determination Green compressive and green shear strength of prepared mold. **Outcomes:** Able to derermine percentage of Moisture content pres Green compressive and green shear strength of mold and will able to judge its effect on quality of casting **Theoretical Background:** Inherent sand properties, types of sand **Experimentation:** ----------	02**Hrs.**

Results and Discussions: ---------- ---------- **Conclusion:** ---------- ----------	
Experiment No. 5 **Aim and Objectives:** Determination of Permeability of given foundry sand. **Outcomes:** Able to derermine percentage of Moisture content present in given foundry Permeability of mold and will able to judge its effect on quality of casting **Theoretical Background:** Inherent sand properties, types of sand **Experimentation:** ---------- ---------- **Results and Discussions:** ---------- ---------- **Conclusion:** ---------- ----------	02**Hrs.**
Experiment No. 6 **Aim and Objectives:** Determination of Mold/Core hardness number. **Outcomes:** Able to derermine mold hardness number and will able to judge its effect on quality of casting **Theoretical Background:** Inherent sand properties, types of sand **Experimentation:** ---------- ---------- **Results and Discussions:** ---------- ---------- **Conclusion:** ---------- ----------	02 **Hrs.**
Experiment No. 7 **Aim and Objectives:** Study of sand Muller and mixture. **Outcomes:** Able to study working of sand muller and to carry out sand preperation **Theoretical Background:** Inherent sand properties, types of sand **Experimentation:** ---------- ---------- **Results and Discussions:** ---------- ---------- **Conclusion:** ---------- ----------	02 **Hrs.**
Experiment No. 8 **Aim and Objectives:** Preparation of specimen for measurement of green/dry shear/compressive strength of mold. **Outcomes:**Abe to prepare sand mold specimen by using Sand Rammer **Theoretical Background:** Inherent sand properties, types of sand **Experimentation:** ---------- ---------- **Results and Discussions:** ---------- ---------- **Conclusion:** ---------- ----------	02 **Hrs.**

Experiment No. 9 **Aim and Objectives:** Preparation of pattern layout: Casting layout sheet, Pattern layout sheet ,Core box layout sheet and cross sectional view of moulding box sheet using CATIA V5 **outcomes:** Able to prepare and dsign pattern by considering pattern allowances and utilize knowledge of CAD/CAM **Theoretical Background:** Types of Pattern, parting plane, core print, pattern making tools, CATIA V5 3D Modelling software **Experimentation:** ---------- **Results and Discussions:** ---------- **Conclusion:** ----------	04 **Hrs.**
Experiment No. 10 **Aim and Objectives:** Casting simulation and design of riser for given casting using virtual simulation **outcomes:** Able to design a feeder of optimum size to increase casting yield **Theoretical Background:** Riser, Feeder, Feedaids,Directional Solidification, Riser Location, Virtual Simulation Software, Optimization Meaning. **Experimentation:** ---------- **Results and Discussions:** ---------- **Conclusion:** ----------	02 **Hrs.**
Experiment No. 11 **Aim and Objectives:** Industrial visit for studying casting operations in a Ferrous / Non ferrous oundry. **outcomes:** Able to understand basic casting processes **Theoretical Background:** Knowledge of Basic casting operations. **Experimentation:** ---------- **Results and Discussions:** ---------- **Conclusion:** ----------	04 **Hrs.**
Textbooks:	
[1] Manufacturing Technology: Foundry, Forming & Welding by P. N. Rao (TMH) [2] Metal Casting – Principles & Practice by T. V. Rama Rao (New Age International Pvt. Ltd.) [3] A Text Book on Foundry Technology by M. Lal, O. P. Khanna(Dhanpat Rai & Co.) [4] A Course on Workshop Technology – Vol. 1 by B. S. Raghuvanshi; (Dhanpat Rai & Co.) [5] Fundamentals of Metal Casting by P. C. Mukharjee (Oxford & IBH Publishing Co). [6] Principles of Foundry Technology by P. L. Jain (Tata McGraw Hill) [7] Foundry Practice by N. D. Titov (MIR) [8] Foundry Engineering by Taylor, Flemings, Wulff (Wiley Eastern Ltd.) [9] Principles of Metal Casting by Heine, Loper, Rosenthal	

References:	
[1]	Casting Technology And Casting Alloys by A.K.Chakrabarti, (PHL Learning Pvt Ltd.)
[2]	Iron and steel making by Ahindra Ghosh, Amit Chatterjee (PHL Learning Pvt Ltd.)
[3]	Complete Casting Handbook-Metal Casting Processes, Metallurgy, Techniques & Design by John Campbell (BH Publication
[4]	Casting simulation website www.efoundryiitb.ac.in
[5]	The FOSECO Foundry man's handbook 10th edition by Butter Worth-Heinemann (BH Publication)
[6]	ASM Handbook Volume 15 on casting
Experiment wise Measurable students Learning Outcomes:	
[1]	Able to determine GFN of foundry sand and will able to judge its effect on quality of casting
[2]	Able to derermine percentage of clay content present in given foundry sand and will able to judge its effect on quality of casting
[3]	Able to derermine percentage of Moisture content present in given foundry sand and will able to judge its effect on quality of casting
[4]	Able to derermine percentage of Moisture content present in given foundry Permeability of mold and will able to judge its effect on quality of casting
[5]	Able to derermine percentage of Moisture content present in given foundry Permeability of mold and will able to judge its effect on quality of casting
[6]	Able to derermine mold hardness number and will able to judge its effect on quality of casting
[7]	Able to study working of sand muller and to carry out sand preperation
[8]	Abe to prepare sand mold specimen by using Sand Rammer
[9]	Able to prepare and dsign pattern by considering pattern allowances and utilize knowledge of CAD/CAM
[10]	Able to design a feeder of optimum size to increase casting yield
[11]	Able to understand basic casting processes

Title of the Course: Thermal Engineering-Lab Course Code: UPRD0332	L	T	P	Credit
	-	-	2	1

Course Pre-Requisite: Basic Mechanical Engineering, Physics

Course Description: Basic Concepts in Thermodynamics, Working of Steam turbine and Condenser, Working Principle of Reciprocating compressor, Working Principle of I. C. Engine.

Course Objectives:

1. To Understand types and working of Steam Boilers.
2. To determine the thermal conductivity of a metal rod.
3. Determine performance parameter of I. C. Engine.
4. To estimate efficiency of Reciprocating Compressor

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Classify Steam Boilers and steam condensers.	II	Understanding
CO2	Understand modes of heat transfer	II	Understanding
CO3	Solve for performance parameters of I.C. Engine and Reciprocating compressor.	III	Applying
CO4	Solve for C.O.P of Refrigerating system.	III	Applying

CO-PO Mapping:

CO	PO1	PO2	PO3	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3															
CO2		3														
CO3		3														
CO4		2														

Agreement: 3-High, 2-Medium, 1-Low.

Assessments :

Teacher Assessment:

One component of In Semester Evaluation (ISE)

Assessment	Marks
ISE	25

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.

Course Contents:

Experiment No. 1:--- Study and Demonstration of Steam Boilers **Aim and Objectives:-- To Classify and explain working of Steam Boilers** **Outcomes:** Students are able to Classify and explain working of various Steam Boilers	2 Hrs
Experiment No. 2:-	

Aim and Objectives: To determine the thermal conductivity of metal rod.	2 Hrs
Experiment No. 3:- **Aim and Objectives:** To determine experimental heat transfer coefficient for natural convection.	
Experiment No. 4:-- Performance Trail on I. C. Engine test rig. Aim and Objectives: A trail on I. C. Engine to determine BSFC and Thermal Efficiency. **Outcomes:** Students are able to determine performance parameter of I.C. Engine.	2 **Hrs.**
Experiment No. 5:--- Trail on Reciprocating air Compressor Test rig. **Aim and Objectives:** A trial on reciprocating air compressor to determine isothermal and volumetric efficiency. **Outcomes:** Students are able to determine compressor efficiencies.	2 **Hrs.**
Experiment No. 6:--- Trial on Reciprocating Compressor **Aim and Objectives:** Determination of COP of Vapour Compression Refrigeration system. **Outcomes:** Students are able to determine COP of Vapour Compression Refrigeration system.	2 Hrs
Experiment No. 7:--- Industrial visit to steam power plant. **Aim and Objectives:** To Classify and explain working of Steam Boilers, mounting and accessories **Outcomes:** Students are able to Classify and explain working of various steam Boilers, mounting and accessories.	2 **Hrs.**
Experiment No. 8:--- Industrial visit to study Refrigeration Plant. **Aim and Objectives:** To classify and explain working of Refrigeration system. **Outcomes:** Students are able to Classify and explain working of various Industrial Refrigeration system.	2 **Hrs.**
Textbooks: 5. Basic and Applied Thermodynamics, 2nd Edition, Nag P. K., Tata McGraw-Hill. 6. Thermodynamics: An Engineering Approach, 3rd Edition, Yunus Çengel and Michael, Boles, Tata McGraw Hill. 7. Yunus A Cengel, Heat transfer -A Practical Approach, McGraw Hill Publication. 8. Mathur and Sharma, Internal Combustion Engines, Dhanpat Rai and Co.	
References: 5. Sonntag, R. E., Borgnakke, C., & Wylen, G. J. V. Fundamentals of thermodynamics: Wiley. 6. Moran, M. J., Shapiro, H. N., Boettner, D. D., & Bailey, M. Fundamentals of Engineering Thermodynamics. 7. V Ganeshan, Internal Combustion Engines, McGraw-Hill. 8. David P. Dewitt, Theodore L. Bergman, Adrienne S. Lavine Frank P. Incropera , Principles of Heat and Mass Transfer, Wiley; Seventh edition (2013)	
Experiment wise Measurable students Learning Outcomes: At the end of each experiment the students will be able to	

1. Determine the thermal conductivity of metallic rod.
2. Determine experimental heat transfer coefficient for natural convection.
3. Determine A trail BSFC and Thermal Efficiency of I. C. Engine.
4. Determine isothermal and volumetric efficiency of reciprocating air compressor.
5. Determination of COP of Vapour Compression Refrigeration system.

Title of the Course: Computer Aided Machine Drawing (CAMD)-Lab Course Code: UPRD0333	L	T	P	Credit
	-	-	2	1

Course Pre-Requisite:

Student must have knowledge and experience about drawing of basic concept in Engineering Graphics.

Course Description:

The students of Production Engineering Programme are mainly involved in drafting, manufacturing, inspection and planning activities (such as preparing process plans, preparing bill of materials, etc.) in industries. For all such activities, reference document is the drawing of component/assembly to be manufactured. In this context, it is of utmost importance to prepare, read and interpret these drawings correctly for production of components and assemblies accurately and precisely. The industrial practices of drafting are also important for the students to make them aware of drafting practices, symbols, codes, norms and standards generally used in industries.

Development of sketching ability also strengthens effective engineering communication & presentation. Now a days the market driven economy demands frequent changes in product design to suit the customer needs. With the introduction of computers the task of incorporating frequent changes as per requirement is becoming simpler. This course has been introduced at 2^{nd} year level in order to develop the skills in student so that they can generate various digital production drawings as required in industry using various CAD software.

Course Objetives:

1. To acquire the knowledge of CAD software and its features.
2. To familiarize the students with Indian Standards on drawing practices.
3. To acquire the knowledge of limits fits and tolerance pertaining to machine drawings
4. To impart knowledge of thread forms, fasteners, keys, joints and couplings.
5. To prepare a working drawing
6. To make the students understand and interpret drawings of machine components so as to prepare assembly drawings using CAD packages

Course Learning Outcomes:

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

1. Apply the CAD Software to represent various mechanical parts.
2. Use IS conventions in representing various machine components and materials.
3. Apply limits, fits and tolerance on machine drawings.
4. Acquire knowledge of thread forms, fasteners, keys, joints and couplings.
5. Develop detailed working drawings of machine component.
6. Prepare assembly drawings from detailed drawings.

CO	Course Outcome (CO) Statement	Bloom's Cognitive level	Descriptor
CO 1	**Recall** the basics of CAD command.	I	Rememberin g

CO 2	**Relate** basics of CAD in machine drawing.	II	Understanding
CO 3	**Apply** IS conventions in machine components.	III	Applying
CO 4	**Apply** dimensions, limits, fits and tolerance on machine components.	III	Applying
CO 5	**Develop** detailed working drawings using machining symbols.	III	Applying
CO 6	**Create** assembly & detailed drawings.	V	Creating

Course Outcomes:

CO-PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	1	-	-	-	-	-	-	-	-	-	-	-
CO4	2	3	2	-	2	-	1	1	2	-	-	-	2	-
CO5	-	-	3	-	3	-	-	-	3	3	-	1	3	-
CO6	-	-	-	-	3	-	-	-	2	2	-	-	1	-

Assessments :

Teacher Assessment:
One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE)

Assessment	Marks (Min. marks for passing=10)
ISE	25
ESE (P.O.E.)	25

ISE are based on practical Internal oral etc.
ESE: Assessment is based practical & oral examination.

Course Contents:

Practical No.1: **Aim** :- Use Drawing aids and Editing Commands **Outcomes:** Able to creating objects (2D) using draw commands.	**3**
Practical No.2: **Aim: -** Basic Dimensioning, Hatching, Blocks and Views on machine component. **Outcomes: -** Able to apply basic dimensioning, hatching, blocks and views on machine component.	**2**
Practical No.3: **Aim: -** To use IS conventions in various machine components and materials. **Outcomes: -** Able to use IS conventions in various machine components and materials.	**3**

Practical No.4: **Aim: -** To select & apply limits, fits and tolerance on machine drawings. **Outcomes: -** Able to select & apply limits, fits and tolerances on machine drawings.	**3**
Practical No.5: **Aim: -** To acquire knowledge of threads forms, fasteners, keys & machining symbols. **Outcomes: -** Able to acquire knowledge of threads forms, fasteners, keys & machining symbols.	**3**
Practical No.6: **Aim: -** To develop detailed working drawings of machine component. **Outcomes: -** Able to develop detailed working drawings of machine component.	**4**
Practical No.7: **Aim: -** To prepare detailed & assembly drawings. **Outcomes: -** Able to prepare detailed & assembly drawings.	**6**

Textbooks:

1. N.D. Bhatt & V.M. Panchal, "Machine Drawing," - Charotar Publishing House, 2001
2. Dr. Dhawan, "A Text Book of Machine Drawing," S. Chand publications 2014
3. Siddheswar, Kannaiyah, and Shastry VVS, "Machine Drawing" , TMH
4. G. Pohit and G. Ghosh, Machine Drawing with AutoCAD –Pearson Education, 2005
5. P.S. Gill, Machine Drawing - S. K. Kataria and Sons, Delhi, 2002
6. AutoCAD-14 for Engineering Drawing Made Easy by P.Nageswara Rao, TMH,2010

References:

1 IS: SP 46- Engineering drawing practice for schools and colleges, BIS Publication.
2. Graphic Science & Design by French, Vierck & Foster (McGraw Hill)
3. Production Drawing: K L Narayana, P Kannaiah,K Venketa Reddy, (New Age International)
4. Machine drawing with Auto CAD Goutam
5. An Introduction to AutoCAD 2000 by A.Yarwood, Longman Publisher.

Experiment wise Measurable students Learning Outcomes:

1. Able to creating objects (2D) using draw commands.
2. Able to apply basic dimensioning, hatching, blocks and views on machine component.
3. Able to use IS conventions in various machine components and materials.
4. Able to select & apply limits, fits and tolerances on machine drawings.
5. Able to acquire knowledge of threads forms, fasteners, keys & machining symbols.
6. Able to develop detailed working drawings of machine component.
7. Able to prepare detailed & assembly drawings.

PROJECT BASED LEARNING (PBL)
S.E. PRODUCTION (SEM-3)

SUB-COMPUTER AIDED MACHINE DRAWING (CAMD) Title of the Course: Computer Aided Machine Drawing (CAMD)-Lab Course Code: UPRD0333	**L**	**T**	**P**	**Credit**
	-	**-**	**2**	**1**

Course Contents:	**Hrs.**
Practical No.1: **Aim :- Use Drawing aids and Editing Commands** **Outcomes:** Able to creating objects (2D) using draw commands.	**3**
Practical No.2: **Aim: -** Basic Dimensioning, Hatching, Blocks and Views on machine component. **Outcomes: -** Able to apply basic dimensioning, hatching, blocks and views on machine component.	**2**
Practical No.3: **Aim: -** To use IS conventions in various machine components and materials. **Outcomes: -** Able to use IS conventions in various machine components and materials.	**3**
Practical No.4: **Aim: -** To select & apply limits, fits and tolerance on machine drawings. **Outcomes: -** Able to select & apply limits, fits and tolerances on machine drawings.	**3**
Practical No.5: **Aim: -** To acquire knowledge of threads forms, fasteners, keys & machining symbols. **Outcomes: -** Able to acquire knowledge of threads forms, fasteners, keys & machining symbols.	**3**
Practical No.6: **Aim: -** To develop detailed working drawings of machine component. **Outcomes: -** Able to develop detailed working drawings of machine component.	**4**
Practical No.7: **Aim: -** To prepare detailed & assembly drawings. **Outcomes: -** Able to prepare detailed & assembly drawings.	**6**

Activities with Duration:-

Practical No.	**Title**	**Activity/Task**	**Duration**
1	Use Drawing aids and Editing Commands ***Content:-***Auto-CAD command	□ Give a simple Product drawing using CAD command.	2 Week
2	Basic Dimensioning, Hatching, Blocks and Views on machine component. ***Content:-***Annotation, Hatching, Dimensioning, Sheet Block Details, Different Views	□ Prepare drawing & add dimensioning, hatching. □ Prepare Title Blocks & Views	1 Week
3	To use IS conventions in various machine components and materials. ***Content:-***Material Symbols, Welding Symbols, Gear, Spring symbols, Threading Symbols	□ Draw a separate Gear, spring, thread □ Place I.S. symbols on prepared drawing.	1 Week

4	To select & apply limits, fits and tolerance on machine drawings. ***Content:-***Introduction, Importance, Fits and Types of Fit, Limits & Types, Tolerance.	□ Place limits, fits, Tolerances on drawing	2 Week
5	To acquire knowledge of threads forms, fasteners, keys & machining symbols. ***Content:-***Thread & Screw Terminology, Form of Threads, Types of Bolt, Nut (Fasters),Types of Keys	□ Draw thread, bolt, Nut, Keys separately.	2 Week
6	To develop detailed working drawings of machine component. ***Content:-***GD&T Concept, GD&T Symbols, M/C ing Symbols.	□ Place all GD&T symbol, M/C ing Symbols on component drawing	1 Week
7	To prepare detailed & assembly drawings. ***Content:-***Draw Detail Drawing, Assembly Drawing, Preparation of Bill of Material	□ Draw a part drawing of small assembly component. □ Draw an simple assembly drawing from part drawing.	3 Week
Total Week		**12 Week**	

Assessments :

Teacher Assessment:
One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE)

Component	**Marks**	
	Max	**Min for passing**
ISE	25	10
ESE(POE)	25	10

Title of the Course: Workshop Practice – II	L	T	P	Credit
Course Code: UPRD0334	-	-	2	1

Course Pre-Requisite:

1. Fundamentals of drawing
2. Fundamentals of metal cutting
3. Cutting machine information

Course Description:

The workshop training aims at providing you practical experience in production of components as well as knowledge and understanding about materials and their machining and finishing. The Machine shop is the heart and soul of Production engineering branch. It deals with the various machining operations such as turning, milling, shaping, thread cutting, slotting, drilling etc.

Course Objectives:

1. To practice basic metal cutting processes and acquire elementary skills.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	Identify different components of lathe according to their function	2	Identify
CO2	Demonstrate basic operations performed on lathe machine	2	Demonstrate
CO3	Attempt grinding of single point cutting tool	3	Attempt
CO4	Perform different operations on lathe machine to convert given raw material into finished job as per specified drawing	5	Perform

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1													
CO2		2												
CO3				2										
CO4						2		2				2		3

Assessments :

Teacher Assessment:

Assessment	Marks
ISE	25

ISE: Assessment is based on 100% lab work.

Course Contents:

Lab section 1:Introduction to basic operations and tools	2 Hrs.
Lab section 2: Drawing reading and process sequence	2 Hrs.
Lab section 3: Manufacturing of components which will include the following operations, facing, plain turning, step turning, external taper turning	10 Hrs.
Lab section 4: Manufacturing of components which will include the following operations, drilling, boring, External threading, internal threading, knurling, Parting	10 Hrs.

Note:-

1. Students should prepare setup wise working drawing showing all the details in work diary.
2. Dimensional accuracy is of prime importance.
3. Student must maintain work diary showing regular progress in the semester.

4. The external practical examination shall include execution of one assigned job & its operation on lathe machine followed by an oral examination.	

Textbooks:

1. Workshop Technology Vol. I & II by Hajra Chaudhary, (Media Promoters & Publishers Pvt. Ltd.)
2. Workshop Technology Vol. I , II and III by W.A.J. Chapman, (ELBS)
3. Workshop Technology Vol. II by Bawa H. S. (TMH)
4. A Course on Workshop Technology – Vol. 1 by B. S. Raghuvanshi; (Dhanpat Rai & Co.)
5. Workshop Technology Vol. III – Chapman (ELBS)

Experiment wise Measurable students Learning Outcomes:

1. Student shall be able to explain basic machining operations
2. Student shall be able to decide process sequence
3. Student shall be able to perform facing, plain turning, step turning, external taper turning operation
4. Student shall be able to perform drilling, boring, external threading, internal threading, knurling, parting operation

Title of the Course: Mini Project	L	T	P	Credit
Course Code: UPRD0341	-	-	2	1

Course Pre-Requisite:

Basic Knowledge of Mechanism.

Course Description:

The mini project is designed to help students develop practical ability and knowledge about practical tools / techniques in order to solve real life problems related to the industry. The course Mini Project is one that involves practical work for understanding and solving problems in the field of mechanization & manufacturing. A group of Students will select topic or issue that they learnt in previous semesters or year. Each group of students will have to prepare proper documentation consisting of problem definition, objectives, Specification, conceptual drawing, final drawing, selection of materials, Manufacturing methods, Testing Methods & costing. The project work will be presented by students in the form of physical model to the panel of Examiners.

Course Objectives:

1. Learn practically and apply knowledge.
2. Realize the value of practical training.
3. To provide employers a chance to distinguish between students with related backgrounds.
4. To encourage hands-on working skills by fabricating simple working mechanisms illustrating technical principles.
5. To develop students to work as a team member or interpersonal skill.
6. To increase writing & communication skill.

Course Learning Outcomes:

Students will be able to

1. Survey literature for problem identification.
2. Apply basic engineering fundamentals in the domain of practical applications to analyze a concept/system/machine operation/process etc.
3. Cultivate the habit of working in a team and attempt a problem solution in a right approach
4. Manufacture a physical working model/prototype/scaled model/ CAD model etc.
5. Prepare project report and present at the end of semester.

Course Outcome

CO	Course Outcome (CO) Statement	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	**Recall** the topics covered in last academic year/semester.	I	Remembering
CO2	**Relate** the topics covered with identified problem definition.	II	Understanding
CO3	**Apply** knowledge and create conceptual drawing.	III	Applying
CO4	**Analyse** different conceptual drawing on the basis of different factors.	IV	Analyzing
CO5	**Evaluate** appropriate process for manufacturing.	V	Evaluating
CO6	**Create** & present a working model/prototype/ CAD model etc.	VI	Creating

CO-PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO 1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	-	2	-	3	-	-	-	-	-	-	-	3	2
CO 4	-	2	-	2	-	2	-	-	3	-	2	-	2	1
CO 5	-	-	-	-	-	-	2	-	-	-	-	-	-	-
CO 6	-	-	-	-	-	-	-	-	-	3		3	-	-

Assessments :

Teacher Assessment

One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE)

Assessment	Marks (Minimum for passing=10)
ISE	25
ESE (P.O.E.)	25

ISE are based on practical Internal oral etc.

ESE: Assessment is based practical & oral examination.

Guidelines

1. Mini Project can be an individual or a group activity depending on the depth and scope of the topic.
2. The project work can be any of the form given below (but not restricted to below mentioned topics only): a) Making physical working models, prototypes, scaled models, of a concept machine.
   b) Making virtual / CAD models of machines / concepts.
   c) Making study, modeling, of a system / machine operation / process.
   d) Making study / teaching modules of a sufficiently complex topic for pedagogy purposes.
3. A complete assembly and details drawings of the project should be submitted along with a detailed project report, where applicable.
4. A Detailed background / field / literature survey, related to the topic must be made presented in the report.
5. Entire work should be presented at the end of the Semester.

Outcomes:

1. **Students will be able to use their knowledge of mechanisms in building working models**
2. **Able to work in teams**
3. **Improves leadership quality**

Title of the Course: Industrial Hydraulics and Pneumatics **Course Code: UPRD0401**	**L**	**T**	**P**	**Credit**
	3	**-**	**-**	**3**

Course Pre-Requisite: Fluid Mechanics

Course Description: This course aims to impart knowledge of fluid power systems such as hydraulics and pneumatics w.r.t. their components, circuits and their applications, design of system and maintenance and troubleshooting of the system.

Course Objectives:

1. To study application of fluid mechanics and governing laws in hydraulic and pneumatic systems.
2. Study of working principle of various components used in hydraulic and pneumatic systems.
3. Study of ISO/JIC symbols of fluid power systems.
4. Selection of different components used in hydraulic and pneumatic systems.
5. Development of hydraulic and pneumatic circuits.
6. Industrial applications of hydraulic and pneumatic circuits.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	**Bloom's Cognitive**	
		level	**Descriptor**
CO1	Students shall demonstrate an understanding of fluid power terms, concepts, and calculations for simple applications	1	Understanding
CO2	The student will be able to select components for application of fluid power (Hydraulics and Pneumatics) in Industries.	2	Applying
CO3	Students shall demonstrate the ability to use and apply hydraulic, Pneumatic and Electro hydraulic schematics to build circuits.	3	Applying

CO-PO Mapping:

CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	1		2			2	2	2		2			1	
CO2	2		2		1	2	2	2	2	2			2	
CO3	2		3		1	3	3	2	3	2				3

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:	
Unit 1: Fundamental concepts of fluid & Introduction to fluid power : Classification of fluids, derivation of Pascal's law, continuity equation and Bernoulli's equation ,Introduction to fluid power: Types, advantages and applications, IService properties of hydraulic fluid, Types of hydraulic fluids, selection of fluid, effect of temperature on fluids, ISO/JIC symbols of various elements of fluid power systems.	**6 Hrs.**
Unit 2: Hydraulic system elements: conditioning of fluids, study of reservoirs, strainers, filters, heat exchangers, effect of temperature on fluid, pumps – types, working, characteristics and applications, power and efficiency calculations (numerical treatment expected), types of conductors and connectors, their selection, seals and packing – types, materials, applications, hydraulic actuators – linear and rotary - types, working, cushioning effect, mounting, calculation of force and velocity of piston (numerical treatment expected), system components: accumulators, intensifiers, their types, working, applications,	**8 Hrs.**
Unit 3: Control Elements: a)construction and working of pressure control valves – direct acting type, pilot operated, sequence, counterbalancing, unloading, pressure reducing, b)Direction control valves – types, construction and working, spool actuation methods, spool center positions, c)Flow control valves – compensated and non compensated types, construction and working.	**6 Hrs.**
Unit 4: Pneumatics: Basic principle, applications, comparison with hydraulic system, Pneumatic system elements: Piping, materials and pressure ratings, piping layout, calculation of pressure drop in pneumatic line; air compressors, types, selection criteria; FRL unit- construction and working; pneumatic cylinders,	**4 Hrs.**
Unit 5: Pneumatic system control elements: Direction control valves- types and working, flow control valves, working of variable flow control, quick exhaust, time delay and shuttle valve. Fluidics: Concept, study of logic gates and applications.	**4 Hrs.**
Unit 6: Hydraulic circuits and their applications: Speed control circuits, regenerative, sequencing, counterbalancing, interlocking, synchronizing circuits, use of accumulator and intensifier, methodology to design hydraulic circuits. , maintenance of fluid power system , Electro -Hydro sytems: concept, working and applications (descriptive treatment only) , Pneumatic circuits: Basic circuit, impulse operation, speed control, sequencing, time delay circuits and their applications, pneumatic clamping systems, pneumatic power tools , maintenance of pneumatic system, Selection of different components such as reservoir, various valves, actuators, filters, pumps based on design. (Students are advised to refer manufacturers' catalogues).	**8 Hrs.**
Textbooks: 1. "Oil hydraulics Systems", S. R. Mujumdar, Tata McGraw Hill Publication. 2. "Pneumatic Systems", S. R. Mujumdar- Tata McGraw Hill Publication. 3. "Industrial Fluid Power",D. S. Pawaskar, Nishant Prakashan. 4. "Hydraulics and Pneumatics", Shaikh and Khan, R.K. Publication.	

5. “Fluid Power with Application”, Esposito, Pearson Education, 7th Edition.
6. “Basic Hydraulic – Festo Manual”
7. “Basic Pneumatic – Festo Manual”
8. “Industrial Fluid Power”, S.S. Kuber, Nirali Prakashan, 3rd Edition.
9. “Hydraulics and Pnuematics”,Dr.Anand Bewoor, Late S.K.Ponde,Nirali Prakashan.

References:

1. “Hydraulic and Pneumatic”,H.L.Stewart,Industrial Press.
2. “Industrial Hydraulic”, J. J. Pipenger, Tata McGraw Hill.
3. “Power Hydraulics”, Goodwin 1st Edition.
4. “Introduction to Hydraulic and Pneumatics”,S. Ilango and V Soundararajan, Prentice Hall of India, 2nd Edition.
5. “Pneumatic Control”,Joji P.,Wiley. , 1st Edition.
6. “Fluid Power”,Jagadeesha T. , Wiley Publications.
7. Eaton (Vickers) Manual.
8. Product Manuals and books from Vickers/ Eaton, FESTO, SMC pneumatics.

Unit wise Measurable students Learning Outcomes:

After completion of units , students are able to:

Understand the fluid power symbols used in hydraulics and pneumatics, various control elements required in hydraulics and pneumatics, different circuits in hydraulics and pneumatics.

Title of the Course: Strength of Materials	L	T	P	Credit
Course Code: UPRD0402	3	-	-	3

Course Pre-Requisite: Types of forces, resolution of forces, geometrical relations

Course Description: The study of strength of materials often refers to various methods of calculating the stresses and strains in structural members, such as beams, columns, and shafts. The methods employed to predict the response of a structure under loading and its susceptibility to various failure modes takes into account the properties of the materials such as its yield strength, ultimate strength, Young's modulus, and Poisson's ratio; in addition the mechanical element's geometric properties such as its length, width, thickness, boundary constraints and abrupt changes in geometry**.**

Course Objectives:

1. Demonstrate knowledge of fundamental concepts and problem solving techniques associated with stress, strain, stress-strain diagram applied to brittle and ductile materials.
2. Applications involving axial loading, torsion, and bending, including introductory-level statically indeterminate systems
3. To have understanding of different loading conditions and its graphical representation to model design problem
4. Accumulate significant practice in solving a variety of application problems in solid mechanics involving concepts of principle stress-strain, deflection of beams and strain energy.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Define basic concepts in structural mechanics to solve simple problems.	1	Remember
CO2	Develop Shear Force and Bending Moment diagram for given loading condition of beam.	3	Apply
CO3	Examine the types of stresses developed in statically determinate member due to loading condition.	4	Analyze
CO4	Combine the effects of Direct and Bending stress on eccentrically loaded structures.	6	Create
CO5	Construct Mohr's Circle to calculate values of Principle Stresses and finding position of Principle planes.	6	Create

CO-PO Mapping:

CO	1	2	3	4	5	6	7	8	9	10	11	12
CO1	2											
CO2	3		1									
CO3	1	2	3									
CO4		3	2									
CO5		2	2									

3: High, 2: Medium, 1: Low

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1: Stress, Strain- Stress – Strain diagrams, factor of safety, failure stress, working stress, Modulus of Elasticity, Rigidity, Bulk Volume, relations, Hook's law,Poisson's ratio,shear stress and shear strain,stress tensor, strain tensor, Stress strain relations, strain energy due to axial forces, strain energy in bending.	9**Hrs.**
Unit 2: Shear force & Bending moments -Shear force and Bending moment computation and diagrams and diagram for statically determinate beams. Application for point loads, UDL, UVL, Intermediate couples on simply supported and cantilever beams. Locating the place of contraflecture and maximum bending moments.	7 **Hrs.**
Unit 3: Bending and Shear stress -Theory of Bending, Flexural formula for straight prismatic beams, Role of Moment of Inertia, for economic use of materials, Neural Axis, Section modulus, moment of resistance, stresses due to bending, beams of uniform strength. Shear stresses in beams due to bending loads, Distribution of shear stresses across plane sections used for common structural purposes.	9 **Hrs**
Unit 4: : Direct and bending stresses- Direct and Bending stresses: Axial loading combined with bending, eccentric loading on plane sections, core of section, middle third rule, applications to the problems of crane hooks, machine columns, brackets etc.	4 **Hrs.**
Unit 5: Deflection of beams -Deflection of statically determinate beams due to bending loads, Macaulay's method. Application for simply supported and cantilever beams. Struts subjected to axial loading, end connections, Empirical design formulae, Euler's and Rankine's methods.	6 **Hrs.**
Unit 6: Principle stresses and principle planes - Principal stresses and planes, general equations for direct stresses in mutually perpendicular directions along with shear stress, Mohr's circle, determination of maximum shear stress and their planes.	5 **Hrs.**

Textbooks:

1. Ferdinand P Beer and E.R. Johnston JR. John Dewolf, Mechanics of Materials 3/e,McGraw Hill Book Company
2. Timoshenko and Young. Elements of Strength of Materials, East-West Press. Pvt. Limited, New Delhi.
3. Rajput, Strength of Materials, Laxmi Publication
4. S.B Junnerkar. Mechanics of structure Vol I, Publication House

5. Bansal, Charotor Strength of Materials, Laxmi Publication
6. E.P.Popov "Mechanics of Materials" Prentice Hall Inc.
7. Andrew P. & Singer F.L., "Strength Of Materials", Harper & Row Publishers
8. G.H. Rider. "Strength of Materials ", Mac Millan India Ltd.
9. Mechanics of Materials Hibbler 2e Pearson Education Publication

References:

1. Den Hartong, Strength of Materials, McGraw Hill, New York.
2. H. BURR and John Cheatam, Mechanical Analysis and Design, PHI, New Delhi.
3. Robert Norton, Machine Design, Prentice Hall

Unit wise Measurable students Learning Outcomes:		
Unit 1	Concept of stress, strain	**ULO1.1:** To use deformation formula for calculation stress and strain. **ULO1.2:** To differentiate normal and shearing stress and strain.
Unit 2	Shear Force and bending Moment Diagram	**ULO2.1:** To study effect of point load, UDL and UVL on Shear Force and Bending Moment Diagram. **ULO2.2:** To study change in Shear Force and Bending Moment Diagram due to loading conditions.
Unit *3*	Bending stresses and Shearing Stresses	**ULO 3.1:** To use flexure formula for calculation of bending stresses and plotting of stress distribution diagram. **ULO3.2:** To use shear stress formula for calculation of shearing stresses and plotting of shear stress distribution diagram.
Unit 4	Direct stresses and bending stresses	**ULO4.1:** To calculate direct stresses and bending stresses. **ULO4.2:** To study effect of both direct and bending stresses due to eccentric loading.
Unit 5	Deflection of beams	**ULO 5.1:** To use Maclaulay's method for calculation of deflection of beam. **ULO 5.2:** To compare critical or cripping load by using Euler's and Rankine's method of axially loaded struts and columns.
Unit 6	Principle stresses and Principle planes	**ULO 6.1:** To calculate normal and shearing stresses on inclined plane for given loading conditions. **ULO 6.2:** To calculate Principle stresses and finding position of Principle planes by using analytical formulae and graphical Mohr's circle.

Title of the Course: Metal Joining Technology Course Code: UPRD0403	L	T	P	Credit
	3	-	-	3

Course Pre-Requisite:

Type of power sources, polarity, voltage, ampere & enthusiasm to learn the subject.

Course Description:

Production engineers need to know different types of metal joining processes for production of intricate part in combination with the accuracy, tolerance & surface finish. The present course intends to give the exposure of various joining processes for a product whose scale ranges from miniature to extra-large. Since joining of metals is an important manufacturing route to fabricate bulk storage and processing equipment's. The subject focuses on knowledge and understanding of various joining process, equipment's, testing methods the underlying principles and their relative merits and demerits. It also helps them to understand the advancement of technology in manufacturing.

Course Objectives:

1. To understand & decide the pre-requisites, critical parameters of metal joining processes.
2. To acquire knowledge of various metal joining processes.
3. To select the appropriate metal joining process.
4. To identify the cause of welding defects and remedies.
5. To check the weldment quality using various inspection and testing methods.
6. To get knowledge of advance metal joining processes.

Course Learning Outcomes:

After the completion of the course the student should be able to

1. Acquire knowledge of various pre-requisites, critical parameters of metal joining processes.
2. Understand the theoretical aspects of welding technology in depth.
3. Select the appropriate welding process for a particular application.
4. Identify the welding defects & suggest their remedies.
5. Check the weldment quality using various inspection and testing methods.
6. Acquire knowledge of advance metal joining processes.

Course Outcomes:

CO	Course Outcome (CO) Statement	Bloom's Cognitive	
		level	Descriptor
CO1	**List** various pre-requisites, critical parameters & different type of metal joining processes.	I	Understanding
CO2	**Classify & Compare** different metal joining processes.	II	Understanding
CO3	**Select & Apply** appropriate welding process for a particular application.	III	Applying
CO4	**Inspect** defects in weldments & **discover** related causes & remedies.	IV	Analyzing
CO5	**Choose** advanced metal joining processes according to requirement.	V	Evaluating
CO6	**Choose** appropriate DT or NDT Test for Testing.	V	Evaluating

CO-PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO 1	-	1	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	2	-	2	-	-	-	1	2	-	-	-	-	-	-
CO 4	-	-	3	-	-	-	-	-	-	-	-	-	-	-
CO 4	-	-	-	-	1	-	-	-	-	-	-	-	-	-
CO 5	-	-	-	-	-	1	-	-	2	-	-	-	2	-
CO 6	-	-	-	2	3	-	-	-	-	-	1	2	2	-

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:	**Hrs.**
Unit 1: Fundamentals and Classification of Metal Joining Processes. **1.a)** Introduction & Classification of Metal Joining Processes. Comparison with other Joining Processes, Advantages, Disadvantages, Practical Applications. Welding Symbols. Basic & Supplementary Weld Symbols, Types of Weld Joints, Selection of Weld Joint. Edge Preparation, Welding Positions, and Weld ability. Safety aspects in Metal joining processes. **1.b)** Power Sources:- Type, Advantage ,Limitations, Application.Compair sources with each other.	**4** **1**
Unit 2: Arc Welding Processes **2.a)** Working Principle, Advantages, Limitation, Application of Carbon arc welding, Flux Shielded Metal arc Welding, Gravity Welding, Sub Merged Arc Welding, GTAW Welding, GMAW Welding, CO2 Welding, Flux Cored Arc Welding (FCAW), Electro Slag welding, Electro Gas welding, Plasma Arc Welding.	**3**

2.b) Welding Electrodes:- Types, Details , Categories of welding electrodes, Ingredients of coating and their functions, Selection of Electrodes, Classification and Coding of mild steel and low alloy steel electrodes as per Indian and American System.	**2**
Unit 3: **3.a) Resistance Welding Processes :-** Introduction, Principle, Working, Specifications, Equipments, Merits and demerits, applications of Spot welding, Seam welding, Projection Welding, Upset welding, Flash Butt welding, Percussion Welding. Heat Shrinkage, Heat Balance Methods. **3.b) Gas Welding:-** Introduction, oxy-acetylene welding, oxy-hydrogen, air-acetylene welding. Principle of operation, types of welding flames, Lighting the torch, flame adjustment, gas welding techniques .welding techniques- leftward & rightward. Filler metals and fluxes, gas welding equipments, applications. **3.c) Soldering and Brazing: -** Basic operational steps of Soldering & Brazing, Role of Flux, Types of Flux, Applications of soldering and brazing in Engineering. Comparison of Soldering, Brazing and Welding	**3** **3** **2**
Unit 4: **4.a) Solid State :-** Introduction, Principle, Working, Specifications, Equipments, Merits and demerits, applications of Solid State welding Processes like Cold (or pressure welding), Diffusion(Bonding), Explosive welding, Friction ,Inertia and forged welding. **4.b) Thermo chemical welding processes** :- Thermit welding, atomic hydrogen welding	**2** **1** **2**
Unit 5: **5. a) Welding Distortion:** Concept of distortion, Types of distortion, Controlling methods of welding Distortion **5. b) Weld Defects: -** Introduction, type of defects in weldments, causes and remedies of defects. **5. c) Quality Test: -** Destructive Tests- Tensile, Bend, Impact, Nick Break, Hardness, Etch Tests. Non-Destructive Tests - Visual, Leak, X- ray and Gamma ray Radiography, Magnetic Particle Inspection, Dye, Fluorescent Penetrant Tests, Ultrasonic Inspection & Eddy Current Testing Pressure and Leak testing.	**2** **2** **3**
Unit 6: **6.a) Welding Automation** Introduction, Automation options, Simple Mechanization, Dedicated and Special Purpose Automation, Advantage, Limitations & Applications. **6.b) Robotic Welding,** Modular Automation, Programmable control, Remote Control Slave and Automated Systems,Advantage,Limitations & Applications. **6.c) Welding Fixtures :-**Introduction, welding fixtures, their characteristics, classification and selection considerations, Principles Governing design of good welding fixtures, various types of welding fixtures.	 **2** **2** **2**

Textbooks:

1. Welding Technology –O.P. Khanna (Khanna Publisher)
2. Welding & Welding Technology-by Richard Little (TMH)
3. Welding Technology –N.K.Srinivasan (Khanna Publisher)
4. Welding Processes and Technology by Dr. R.S.Parmar (Khanna Publisher)

References:

1. Welding Science & Technology by Md. Ibrahim Khan (New Age International)
2. Welding Technology & Design by V.M.Radhakrishnan (New Age International Publisher)
3. Welding Guide and Handbook by- James E Brambaugh (Taraporwala Mumbai)
4. Welding by A.L. Davies – (Cambridge University Press.)
5. Welding Process Technology – P.T.Houltcroft (Cambridge University Press.)
6. Principles of Welding Technology- by L.M.Gourd (ELBS)
7. Advanced Welding systems- Vol...I ,II and III by Jeam Cornu (Jaico Publishing)
8. Arc and Gas welding- V. Rybakav (Mir Publication)
9. Practical Welding Technology- Rudy Molher (Industrial Press Inc.)
10. Manufacturing Technology: Foundry, Forming & Welding by P. N. Rao (TMH)

Unit wise Measurable students Learning Outcomes:

1. Understand & decide the pre-requisites, critical parameters of metal joining processes & power sources.
2. Get the knowledge of theoretical aspects of Arc welding Processes & Electrode
3. Get the knowledge of theoretical aspects of Resistance,Gas,Soldering,Brazing welding Processes
4. Understand working of different advanced metal joining processes.
5. Able to understand distortion, defects, causes, remedies & different DT & NDT Test.
6. Understand the need of automation, robotics and fixture in metal joining processes

Textbooks:

1. Welding Technology –O.P. Khanna (Khanna Publisher)
2. Welding & Welding Technology-by Richard Little (TMH)
3. Welding Technology –N.K.Srinivasan (Khanna Publisher)
4. Welding Processes and Technology by Dr. R.S.Parmar (Khanna Publisher)

References:

10. Welding Science & Technology by Md. Ibrahim Khan (New Age International)
11. Welding Technology & Design by V.M.Radhakrishnan (New Age International Publisher)
12. Welding Guide and Handbook by- James E Brambaugh (Taraporwala Mumbai)
13. Welding by A.L. Davies – (Cambridge University Press.)
14. Welding Process Technology – P.T.Houltcroft (Cambridge University Press.)
15. Principles of Welding Technology- by L.M.Gourd (ELBS)
16. Advanced Welding systems- Vol...I ,II and III by Jeam Cornu (Jaico Publishing)
17. Arc and Gas welding- V. Rybakav (Mir Publication)
18. Practical Welding Technology- Rudy Molher (Industrial Press Inc.)
10. Manufacturing Technology: Foundry, Forming & Welding by P. N. Rao (TMH)

Unit wise Measurable students Learning Outcomes:

7. Understand & decide the pre-requisites, critical parameters of metal joining processes & power sources.
8. Get the knowledge of theoretical aspects of Arc welding Processes & Electrode
9. Get the knowledge of theoretical aspects of Resistance,Gas,Soldering,Brazing welding Processes
10. Understand working of different advanced metal joining processes.
11. Able to understand distortion, defects, causes, remedies & different DT & NDT Test.
12. Understand the need of automation, robotics and fixture in metal joining processes

Title of the Course: Metallurgy	**L**	**T**	**P**	**Credit**
Course Code: UPRD0404	**3**	**1**	**-**	**4**

Course Pre-Requisite:

Fundamental knowledge of crystals structure and meaning of materials, chemistry of Metals and alloys.

Course Description:

Materials science and engineering plays a vital role in this modern age of science and technology. To meet the plant and individual requirements selection of a specific material for a particular use is a very complex process. Metallurgy is the science of materials. The central point of this course is to provide a physical basis that links the structure of materials with their properties, focusing primarily on ferrous and nonferrous metals. With this understanding in hand, the concepts of alloy design and microstructural changes during cooling are also discussed, Heat treating is a group of industrial and metalworking processes as hardening, normalizing and annealing etc. are used to alter the physical, and sometimes chemical, properties of a material.

Course Objectives

1) To select proper ferrous or nonferrous metal material as per given application by considering metallurgical and mechanical properties in accordance with its phase diagram with proper justification.
2) To explain cooing of any given alloy schematically.
3) To calculate percentage of various phases present in solid solution at given temp and composition by using lever rule analytically.
4) To draw various types of equilibrium diagrams of Ferrous and Non Ferrous materials, TTT and CCT diagram graphically.
5) To clearly distinguish between various types of heat treatment process.

Course Outcomes:

CO	**After the completion of the course the student should be able to**	**Bloom's Cognitive**	
		Level	**Descriptor**
CO1	**Select** proper material for given application by considering metallurgical and mechanical properties with proper justification.	I	Knowledge & skill
CO2	**Explain** cooing of any given alloy schematically.	II	Knowledge
CO3	**Interpret** various types of equilibrium diagrams of Ferrous and Non Ferrous materials, TTT and CCT diagram graphically.	II	Knowledge
CO4	**Solve** numerically percentage of various phases present in solid solution at given temp and composition by using lever rule .	III	Knowledge

CO5	To **apply** core concepts in Materials Science to solve engineering problems.	III	Knowledge
CO6	**Distinguish** between various types of heat treatment process.	IV	Knowledge

CO-PO Mapping:

CO	1	2	3	4	5	6	7	8	9	10	11	12
CO1	**2**											
CO2	**2**											
CO3			**2**									
CO4		**2**	**2**									
CO5	**2**											
CO6				**3**								

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/Moodle quiz/Topic seminar/Group Discussions, Industrial case study etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1: Introduction to Metals and alloy system 8**Hrs.**

Material Classification, Crystallography, Unit Cell, study of crystal structures of SC., BCC, FCC. & HCP, APF, Introduction to Advanced materials, phases, components, degree of freedom, Construction of phase diagram using cooling curves, Isomorphous systems, Eutectic system, Eutectoid, Peritectic. Solid solutions and its types, Intermediate phases

Unit 2: Study of ferrous equilibrium diagrams, with respect to compositions, properties and applications for following alloys 7 **Hrs.**

Fe-Fe3C Equilibrium diagram for plain carbon steels, Effect of carbon on structure and

properties, Free cutting steels, Alloy steels , Dual phase steels, micro alloyed steels, High strength low alloy steels, transformation inducted plasticity (TRIP) steels, Tool steels, Stainless steels, Heat resisting steels, HSLA steels, Low temperature alloys, Invar, Hadfield steel, Spring steel, Cast Irons - Fe-C Equilibrium Diagram, Factors Affecting Structure of C.I.(graphitization), C.E of cast iron, Alloy C.I., SG Iron, Ni-Hard, modified Ni- Hard and Ni-Resists,

Unit 3: Study of non-ferrous equilibrium diagrams, compositions, properties, applications and specifications of important alloys 3**Hrs.**

Copper-based alloys, Aluminum-based alloys ,modification treatment, Titanium- and Mg based ,Non-ferrous equilibrium diagrams - Pb-Sn : solders, Sn-Sb : Babbit

Unit 4: Introduction and Principles of Heat Treatment Processes of Steels , Heat treatment furnaces, atmospheres, defects and energy economy 8**Hrs.**

Introduction to heat treatment Process, purpose , process variables, Transformation of Pearlite on heating and cooling, TTT and CCT Diagram and significance, Effect of alloying dements on TTT diagram and its significance, Heat treatment furnaces, control systems, furnace atmospheres, Heat treatment defects, causes and remedies, Energy economy

Unit 5: Heat treatment process of steels, cast iron and Non ferrous alloys. 10**Hrs.**

Annealing, Hardening, Normalizing - Classification comparison and application of processes, hardenability ,factors affecting hardenability, determination of hardenability, hardening methods, Tempering - Purposes , types, structural changes during tempering, temper brittleness. Heat treatment process of Cast Irons –Stress relief annealing, normalizing, hardening, surface, hardening and malleablising, annealing. Surface and case hardening processes: Case Hardening, Carburizing, Nitriding, Surface Hardening: Flame hardening, induction hardening, electron beam hardening and laser hardening, Case depth measurement - hardness method, chemical method, microstructure method.

Unit 6: Powder Metallurgy and material testing 4 **Hrs.**

Importance of process as a manufacturing technique, advantages and limitations of powder metallurgy, Methods of powder manufacture, , powder conditioning, blending and mixing, Powder compaction - Methods of compaction, Sintering - Types of sintering, structure and property changes during sintering, sintering atmospheres and their importance. Finishing operations - Sizing, heat treatment, surface treatment, electroplating and impregnation treatments, Applications as Self-lubricating (porous) bearings, electric contact materials, filters, magnets, sintered friction materials, cutting tools and cermets, flow charts for manufacturing of above components. Material testing- Tensile test, Izod and charpy impact test, Fatigue test, Hardness measurement methods.

Textbooks:

[1] Vijendra Singh. Engg. Physical Metallurgy, Standard Publishers, Delhi

[2] V.D. Kodgire, Material science and metallurgy, Everest Publishers Pune

[3] T.V. Rajan & C.P. Sharma, Heat Treatments Principles & Practices, PHI.

[4] A.K. Sinha, Powder Metallurgy
[5] Phase transformation in metals and alloys by K.E Easterling, D.A. Poater, Chapman & Hall, 1992.
[6] Structure & properties of alloys: the application of phase diagrams to the interpretation and control of industrial alloy structures by Brick, Gordon and Phillips, McGraw-Hill.
[7] Heat treatment of metals by Vijendra Singh, Standard Publishers Distributors, 2006.
[8] S.H.Avner, Physical Metallurgy, TMH publication.
[9] Rollson , Metallurgy for Engg. Technicians, English language Book Society
[10] Higgins R. A., Hodder, Engineering Metallurgy I and II, English language Book Society.
[11] Prabhudev, Heat treatment of Steels, HMT Handbook
[12] G.E. Dieter, Mechanical Metallurgy, Tata McGraw-Hill, New Delhi.
[13] Engineering Physical Metallurgy - Lakhtin, C.B.S. Publishers & Distributors
[14] Heat treatment of Metals – B. Zaharov, C.B.S. Publishers & Distributors India
[15] Material science and Metallurgy, C. Daniel Yesudin, D. G. Harris Samuel Scitech
[16] Material Science And Engineering , Callister Wiley India Edition
[17] ASM Handbooks, American Society of Metals

References:

[1] S.H.Avner, Physical Metallurgy, TMH publication.
[2] Rollson , Metallurgy for Engg. Technicians, English language Book Society
[3] Higgins R. A., Hodder, Engineering Metallurgy I and II, English language Book Society.
[4] Prabhudev, Heat treatment of Steels, HMT Handbook
[5] G.E. Dieter, Mechanical Metallurgy, Tata McGraw-Hill, New Delhi.
[6] Engineering Physical Metallurgy - Lakhtin, C.B.S. Publishers & Distributors
[7] Heat treatment of Metals – B. Zaharov, C.B.S. Publishers & Distributors India
[8] Material science and Metallurgy, C. Daniel Yesudin, D. G. Harris Samuel Scitech
[9] Material Science And Engineering , Callister Wiley India Edition
[10] ASM Handbooks, American Society of Metals

Unit wise Measurable students Learning Outcomes:

Unit 1	Introduction to Metals and alloy system	At the end of course Student will be Able to Select proper material for given application by considering metallurgical and mechanical properties with proper justification.
Unit 2	Study of ferrous equilibrium diagrams, with respect to compositions, properties and applications for following alloys	At the end of course Student will be Able to Explain cooing of any given ferrous alloy schematically and analytically Also able To draw various types of equilibrium diagrams of Ferrous materials, TTT and CCT diagram graphically
Unit 3	Study of non-ferrous equilibrium diagrams, compositions, properties, applications and specifications of important alloys	At the end of course Student will be Able to Explain cooing of any given nonferrous alloy schematically and analytically. Also able To draw various types of equilibrium diagrams of Non Ferrous materials, TTT and CCT diagram graphically
Unit 4	Introduction and Principles of Heat Treatment Processes of	At the end of course Student will be Able to explain TTT and CCT diagram graphically and will be Able to

	Steels , Heat treatment furnaces, atmospheres, defects and energy economy	distinguish between heat treatment defects and will be able to suggest a possible remedies to overcome for defects.
Unit 5	Heat treatment process of steels, cast iron and Non ferrous alloys.	At the end of course Student will be Able to select and suggest a proper heat treatment for given steels, cast iron and Non ferrous alloys.
Unit 6	Powder Metallurgy and material testing	At the end of course Student will be Able to List sequence of operations to be followed in producing components by powder metallurgy and to carry out material testing .

Title of the Course: THEORY OF MACHINES	L	T	P	Credit
Course Code: UPRD0405	3	1	-	4

Course Pre-Requisite:

Prerequisite for the course is completion of course of Applied Mechanics and Engineering Mathematics. Fundamentals of engineering mechanics including forces acting on bodies at rest, free body diagram, determination of equilibrium equations, differentiation and integration. In addition, the students should have adequate knowledge about graphical skills and analytical skills.

Course Description:

Theory of Machines is a fundamental course for Production engineers to understand the working principles of any machine. This course is essential to understand the motion, transmission of the motion and the forces responsible for the motion. The major focus is on determination of displacement, velocity & acceleration of different links of the mechanisms using Graphical method Also the course is intended to build up necessary background for understanding the dynamic behavior of machines. It focuses on the Balancing of rotary and reciprocating masses, Gyroscope, Basics of vibrations, free undamped and damped vibration, forced vibration. Apart from above, study of simple mechanisms, Brakes and Dynamometer, study of governors, toothed wheels and gear train are the major contents of the syllabus.

Course Objectives:

1. To be familiar with common mechanisms used in machines and everyday life.
2. To provide basic concept of kinematics and kinetics of machine elements.
3. To develop the ability to understand the concepts of mechanisms and the kinematic analysis of mechanisms.
4. To understand the basics of gear design and motion analysis and selection of gears and gear trains.
5. To demonstrate different types of gear trains and its applications.
6. To acquaint with working principles and applications of gyroscope and governors
7. To understand the procedure and effect of static and dynamic balancing of rotary and reciprocating masses.
8. To give awareness to students on the phenomenon of vibrations and its effects.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	**Explain** the basic relation between velocity and acceleration for mechanisms.	1	Knowledge

CO2	**Define** various terminologies related to kinematics of gear, gear train, and gyroscope.	1	Knowledge
CO3	**Describe** basic elements of gear design and motion analysis and selection of gear and gear trains.	2	Knowledge
CO4	**Calculate** the balancing masses for rotary and reciprocating disturbing masses.	3	Knowledge
CO5	**Analyze** simple dynamic systems.	4	Knowledge

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:--- **1.1 Introduction**: Theory of machines – scope, definitions-machine, mechanism, link, kinematic pair, classification of kinematic pairs, conversion, inversion and expansion of mechanism, study of four bar chain, single slider and double slider crank chain and its inversions. **1.2:--- Simple Mechanisms:** Condition for steering, Ackerman's steering mechanism, Davis steering mechanism, Hooke's Joint. (Numerical treatment expected on Hooke's Joint)	**6 Hrs.**
Unit 2:--- Kinematic Analysis of Mechanisms: **2.1 Velocity Analysis** Concept of position, displacement and velocity of a point and link of a given mechanism, Kinematic analysis of mechanisms by - Relative velocity method, graphical method, (mechanisms up to 6 links) Instantaneous Center method, (mechanisms up to 4 links) (Numerical treatment expected) 2.2 **Acceleration Analysis** Concept of acceleration of a point and link of a given mechanism, Kinematic analysis of mechanisms by -- Relative method, graphical method, Corioli's Component of Acceleration , (Numerical treatment expected)	**10 Hrs.** **(5 hours)** **(5 hours)**

Unit 3:---3.1 GEAR: Introduction, law of gearing, length of path of contact, arc of contact, contact ratio, interference of involute gear teeth. (numerical treatment expected on spur gear) **3.2GEAR TRAIN :** Types of gear train, torques in epicyclic gear train analysis of gear trains. (numerical treatment expected on epicyclic gear train)	**3 Hrs.** **4 Hrs.**
Unit 4:--- BALANCING: Static and dynamic balancing, balancing of rotary masses, masses in the same plane, masses in different planes, balancing of reciprocating masses, primary and secondary balancing, balancing of locomotives (numerical treatment expected), balancing of multi-cylinder inline engines, balancing of V-engines.	**6 Hrs.**
Unit 5:--- GYROSCOPE: Introduction, Gyroscopic couple, Effect of gyroscopic couple on motion of aero plane, naval ship, two and four wheelers, Gyroscopic stabilization.(numerical treatment expected)	**5 Hrs.**
Unit 6:--- VIBRATIONS: **9.1 Longitudinal and transverse vibrations**: Introduction, types, natural frequency for various loading systems, Dunkerly's empirical formula, critical speed of shaft. (numerical treatment expected) **9.2 Torsional vibrations:** Introduction, natural frequency for single, two and three rotor system, torsionally equivalent shafts, free torsional vibrations of a geared system. (numerical treatment expected)	**6 Hrs.** **(3 hours)** **(3 hours)**

Textbooks:

01. Theory of Machines and Mechanisms, by P. L. Ballaney, (Khanna Publishers, Delhi)

02. Theory of Machines, by S. S. Ratan, (TMH)

03. Theory of Mechanism and Machines by Ghosh and Mallik (EWP)

04. Theory of machines, by Dr. R.K.Bansal, Laxmi Publication

05. Theory of Machines by R.S. Khurmi S.Chand and co.

06. Theory of Machines, by Thomas Bevan, (CBS Publishers, Delhi)

References:

01. Theory of Machines and Mechanisms, by John Uiker, Garden Pennock & Late. J. F. Shigley,

(Mc Graw Hill Publications)

02. Theory of Machines, by W. Green,

03. Kinematics of Machines by R T Hinckle (Prentice Hall Inc.)

04. Kinematics by V.M. Fairs (McGraw Hill)

05. Mechanism Design: Analysis and Synthesis Vol. I by A. Erdman and G.N. Sander (Prentice Hall)

06. Kinematics and Dynamics of Planer Mechanisms by Jeremy Hirsihham (McGraw Hill)

07. "Machines and Mechanisms Applied Kinematic Analysis", David H. Myszka, Pearson Education, Asia.

08. "Design of Machinery", R. L. Norton, McGraw-Hill.

09. Mechanical vibrations G.K. Grover

10. Mechanical Vibration Analysis- P.Srineevasan- Tata McGraw Hill

11. Theory and Practice of mechanical vibrations J.S.Rao K.Gupta – New Age International Publications.

12. "Design of Machinery", R. L. Norton, McGraw-Hill.

13.Theory of vibrations with applications- W.T.Thompson-Prentice Hall of India

14. Mechanical Vibrations- Schaum's outline series- McGraw Hill

Unit wise Measurable students Learning Outcomes:

Unit – 1 Introduction and Simple mechanisms	Students will be able to identify the Mechanism and differentiate between the mechanism. Students will be able to solve the problem on hooks joint and differentiate between steering mechanisms.
Unit – 2 Kinematic Analysis of Mechanisms:	Students will be able to calculate velocity and acceleration of a given mechanism.

Unit – 3 Gear and Gear Trains	1. Student will be able to analyze Kinematics of gear. 2. Students will be able to solve Problems on gear train. 3. Students will be able to Calculate speed of a gear for a Given train	
Unit- 4 Balancing	Students will be able to solve Static and dynamic balancing Problems.	
Unit – 5 Gyroscope	Students will be able to analyze Gyroscopic effect and solve Problems related to gyroscope.	
Unit – 6 Vibrations	Students will be able to understand Basics of Vibrations. Students will be able to solve simple Problems of vibrations. Students will be able to analyse Simple system from vibration point Of view.	

Title of the Course: Audit Course – I: Environmental Studies Course Code: UPRD0461	L	T	P	Credit
	2	-	-	Audit Course

Course Pre-Requisite:

Students shall have knowledge of:

- Science
- Technology

Course Description:

The objective of the course is imparting fundamental knowledge and awareness of Environmental science among students *and importance of conservation of environment.*

Course Objectives:

At the end of the course students will be able to

1. Study scope and importance of natural resources, ecosystems, biodiversity for creating awareness and their conservation in multiple disciplines.
2. Learn various types of pollution, their impacts and control measures for minimizing pollution and sustainable development.
3. Understand social issues related environment, environmental ethics and human rights towards environment.
4. Study various laws & regulations related to environment and its applicability in society and industries.
5. Choose one of the sectors of environment for detail study as project.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Descriptor
CO1	Describe natural resources, importance of ecosystem & conservation of biodiversity with respect to multiple disciplines.	Cognitive
CO2	Explain causes, effects, solutions for various pollution problems and its minimization strategies.	Cognitive
CO3	Discuss environmental ethics & their implementation for betterment of environment & human life.	Cognitive
CO4	Differentiate between requirements of laws & regulations for environmental conservation and applicability of legislations in society and industries.	Cognitive
CO5	Prepare detailed project report on selected topic based on environmental issues/problems.	Cognitive

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1							2					
CO2	3											
CO3								2				
CO4						2						
CO5										2		

Assessments :

Assessment	Weightage (Marks)
ESE	50

ESE: Assessment is based on 100% course content.

Course Contents:

Module 1:Nature of Environmental Studies Definition, scope and importance, Multidisciplinary nature of environmental studies, Need for public awareness.	**4 Hours**
Module 2: Natural Resources and Associated Problems a) Forest resources: Use and over-exploitation, deforestation, dams and their effects on forests and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams benefits and problems. c) Mineral resources: Usage and exploitation. Environmental effects of extracting and using mineral resources. d) Food resources: World food problem, changes caused by agriculture effect of modern agriculture, fertilizer-pesticide problems. e) Energy resources: Growing energy needs, renewable and nonrenewable energy resources, use of alternate energy sources. Solar energy, Biomass energy, Nuclear energy. f) Land resources: Solar energy , Biomass energy, Nuclear energy, Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individuals in conservation of natural resources.	**4 Hours**
Module 3: Ecosystems Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers. Energy flow in the ecosystem, Ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristics features, structure and function of the following ecosystem :- a) Forest ecosystem, b) Grassland ecosystem, c) Desert ecosystem, d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).	**6 Hours**
Module 4:Biodiversity and its conservation Introduction- Definition: genetic, species and ecosystem diversity. Bio-geographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. India as a mega- diversity nation, Western Ghat as a biodiversity region. Hot-spot of biodiversity. Threats to biodiversity habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.	**6 Hours**
Module 5:Environmental Pollution Definition: Causes, effects and control measures of: Air pollution, Water pollution, soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards. Solid waste Management: Causes, effects and control measures of urban and industrial wastes. Role of a individual in prevention of pollution.	**6 Hours**

Module 6: Social Issues and the Environment Disaster management: floods, earthquake, cyclone, tsunami and landslides. Urban problems related to energy Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issue and possible solutions. Global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Wasteland reclamation. Consumerism and waste products.	**8 Hours**
Module 7:Environmental Protection From Unsustainable to Sustainable development. Environmental Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Population Growth and Human Health, Human Rights.	**8 Hours**

Textbooks:

1. Environmental Studies by Dr. P.D.Raut (Shivaji University, Kolhapur)

References:

1. Miller T.G. Jr., Environmental Science. Wadsworth Publications Co.(TB).
2. Odum, E.P.1971, Fundamentals of Ecology, W.B.Saunders Co. USA,574p
3. Trivedi R.K. Handbook of Environmental Laws, Rules, Guidelines,Compliances and Standards, vol. I and II, Environmental Media (R)

Unit wise Learning Outcomes:

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

UO 1	Describe scope and importance of environmental studies.
UO 2	Describe types of natural resources, their use and conservation.
UO 3	Explain structure and functions of ecosystem, their types and importance.
UO 4	Discuss biodiversity, endangered species and methods of biodiversity conservation.
UO 5	Explain causes, effects and solutions to pollution problems.
UO 6	Discuss environmental ethics and various social issues related to environment.
UO 7	Discuss laws and regulations for conservation of environment.

Title of the Course: Industrial Hydraulics and Pneumatics **Course Code: UPRD0431**	**L**	**T**	**P**	**Credit**
	-	**-**	**2**	**1**

Course Pre-Requisite: Fluid Mechanics

Course Description: This course aims to impart knowledge of fluid power systems such as hydraulics and pneumatics w.r.t. their components, circuits and their applications, design of system and maintenance and troubleshooting of the system.

Course Objectives:

1. To study application of fluid mechanics and governing laws in hydraulic and pneumatic systems.
2. Study of working principle of various components used in hydraulic and pneumatic systems.
3. Study of ISO/JIC symbols of fluid power systems.
4. Selection of different components used in hydraulic and pneumatic systems.
5. Development of hydraulic and pneumatic circuits.
6. Industrial applications of hydraulic and pneumatic circuits.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	**Bloom's Cognitive**	
		level	**Descriptor**
CO1	Students shall demonstrate an understanding of fluid power terms, concepts, andcalculations for simple applications	1	Understanding
CO2	The student will be able to select components for application of fluid power (Hydraulics and Pneumatics) in Industries.	2	Applying
CO3	Students shall demonstrate the ability to use and apply hydraulic, Pneumatic and Electro hydraulic schematics to build circuits.	3	Applying

CO-PO Mapping:

CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	1		2			2	2	2		2			1	
CO2	2		2		1	2	2	2	2	2			2	
CO3	2		3		1	3	3	2	3	2				3

Assessments :

Teacher Assessment:

One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

Assessment	Marks
ISE	25
ESE (P.O.E.)	25

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.

ESE: Assessment is based on oral examination

Course Contents:	
Experiment No. 1:--- Bernoulli‘s Theorem on Bernoulli‘s apparatus.	
Experiment No. 2:---Study of pressure, direction and flow control valves in hydraulics and pneumatics using cut section models	
Experiment No. 3:---Meter-in, Meter-out and Bleed-off, Sequencing, Counterbalancing, Synchronizing, Interlocking circuits on hydraulic trainer.	
Experiment No. 4:---Manual / automatic forward – reverse, sequencing, Basic logic circuits on pneumatic trainer.	
Experiment No. 5:---Eletcro-Hydraulic systems- study and simple circuits.	
Experiment No. 6:---Design of a hydraulic circuit for a given application and selection of components from commercial catalogs.	
Experiment No. 7:---industrial visit to study industrial applications of hydraulics and pneumatics with submission of the relevant report.	

Textbooks:

1. “Oil hydraulics Systems”, S. R. Mujumdar, Tata McGraw Hill Publication.
2. “Pneumatic Systems”, S. R. Mujumdar- Tata McGraw Hill Publication.
3. “Industrial Fluid Power”,D. S. Pawaskar, Nishant Prakashan.
4. “Hydraulics and Pneumatics”, Shaikh and Khan, R.K. Publication.
5. “Fluid Power with Application”, Esposito, Pearson Education, 7th Edition.
6. “Basic Hydraulic – Festo Manual”
7. “Basic Pneumatic – Festo Manual”
8. “Industrial Fluid Power”, S.S. Kuber, Nirali Prakashan, 3rd Edition.
9. “Hydraulics and Pnuematics”,Dr.Anand Bewoor, Late S.K.Ponde,Nirali Prakashan.

References:

9. “Hydraulic and Pneumatic”,H.L.Stewart,Industrial Press.
10. “Industrial Hydraulic”, J. J. Pipenger, Tata McGraw Hill.
11. “Power Hydraulics”, Goodwin 1st Edition.
12. “Introduction to Hydraulic and Pneumatics”,S. Ilango and V Soundararajan, Prentice Hall of India, 2nd Edition.
13. “Pneumatic Control”,Joji P.,Wiley. , 1st Edition.
14. “Fluid Power”,Jagadeesha T. , Wiley Publications.
15. Eaton (Vickers) Manual.
16. Product Manuals and books from Vickers/ Eaton, FESTO, SMC pneumatics.

Experiment wise Measurable students Learning Outcomes:

Student shall be able to-

Experiment No. 1:--- understand the theory of Bernoulli‘s.
Experiment No. 2:--- Study various control valves in hydraulics and pneumatics
Experiment No. 3:--- study various circuits on hydraulic trainer.
Experiment No. 4:--- study various circuits on pneumatic trainer.
Experiment No. 5:---study Eletcro-Hydraulic systems and simple circuits.
Experiment No. 6:--- Planning of a hydraulic circuit for a given application from commercial catalogs.

Experiment No. 7:---industrial visit to study industrial applications of hydraulics and pneumatics with submission of the relevant report.

Course Code	Course Name	Hr/Week			Credits
		L	T	P	
UPRD0432	Metal Joining Technology- Lab	-	-	2	1

Course Pre-Requisite:

Zeal to learn the Subject through practical work.

Course Description:

Production engineers need to know different types of metal joining processes for production. The present course intends to give the exposure of various joining processes for a product whose scale ranges from miniature to extra-large. Since joining of metals is an important manufacturing route to fabricate bulk storage and processing equipment's. The subject focuses on understanding and performing various joining process and equipment's, the underlying principles and their relative merits and demerits. It also helps them to understand the advancement in the technology in metal joining.

Course Objective:

- To understand the concepts of metal joining process.
- To classify different metal joining methods.
- To perform on different metal joining methods.
- To understand the concepts of testing for welded joint.
- To provide a limited amount of experience welding**.**
- To bridge up the gap between the demand of the industry & the academic curriculum.

Course Learning Outcome:

- After learning the course the students should be able to:
- Acquire knowledge of various welding processes.
- Select the appropriate metal joining process.
- Decide the process parameters suitable for the material & processes.
- Apply knowledge of various Mechanical testing of welded joints.
- Apply knowledge of various NDT testing of welded joints.

Course Outcomes:

CO No.	Course Outcome (CO) Statement	Bloom's Cognitive	
		Level	Descriptor
1	**List out & Select** the different metal joining parameters.	**I**	Remembering
2	**Classify & Compare** the different metal joining processes.	**II**	Understanding
3	**Apply appropriate** metal joining processes.	**III**	Applying
4	**Inspect** the quality of weld joint using destructive and non-destructive testing	**IV**	Analyzing

CO-PO Mapping-

CO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO1	PO1	PSO	PSO
CO	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO	3	2	-	-	-	-	-	-	-	-	-	-	-	2
CO	2	-	3	-	3	-	-	-	2	-	-	-	-	-
CO	2	-	-	2	3	-	2	-	-	-	-	2	2	-

Assessments :

Evaluation Scheme		
Component	**Marks**	
	Max	**Min for Passing**
ISE	25	10
ISE based on assignment, Metal Joining Job, Moodle quiz, Topic seminar, Group Discussions, Industrial case study etc.		

Course Contents:	**Hrs.**
Experiment No.01 – Aim:-To identify and understand various safety aspect of welding. **Outcome:** Able to identify and understand various safety aspect of welding.	**1**
Experiment No.02-Aim:-To study & understand different Power source used in Welding with its specific application **Outcome:** Able to understand different Power source used in Welding with its specific application	**1**
Experiment No.03 - Aim:-To study the specifications of electrodes / filler wires used in welding **Outcome:** Able to select electrodes / filler wires used in welding	**1**
Experiment No.04 - Aim:-To understand and perform Arc Welding Operation with its application. **Outcome:** Able to understand and perform Arc Welding Operation with its application.	**2**
Experiment No.05 - Aim:-To Understand and perform Spot welding Operation and process with its application. **Outcome:** Able to understand and perform Spot welding Operation and process with its application.	**1**
Experiment No.06 - Aim:-To understand and perform MIG Welding Operation with its application. **Outcome:** Able to understand and perform MIG welding Operation and process with its	**2**

application.	
Experiment No.07 – Aim:-To understand and perform gas welding Operation with its application. **Outcome:** Able to understand and perform gas welding Operation with its application.	**2**
Experiment No.08 – Aim:-To understand and perform soldering operation with its application. **Outcome:** Able to understand and perform soldering operation with its application.	**2**
Experiment No.09– Aim:-To identify and understand various welding defects, causes and their remedies. **Outcome:** Able to identify and understand various welding defects, causes and their remedies.	**2**
Experiment No.10– Aim:-To understand &perform the various DT and NDT methods for weld joints. **Outcome:** Able to understand and perform the various DT and NDT methods for weld joints	**2**
Experiment No.11– Aim:-To study advanced welding processes through Industrial Visit **Outcome:** Able to observe advanced welding processes.	**2**
Text books:	

1. Parmer R.S., "Welding Engineering and Technology", 1st edition, Khanna Publishers, New Delhi, 2008.

2. Parmer R.S., "Welding Processes and Technology", Khanna Publishers, New Delhi, 1992. 87

3. Little R.L., "Welding and welding Technology", Tata McGraw Hill Publishing Co., Ltd., New Delhi, 34th reprint, 2008.

References:

1. Schwartz M.M. "Metals Joining Manual". McGraw Hill Books, 1979.
2. Tylecote R.F. "The Solid Phase Welding of Metals". Edward Arnold Publishers Ltd. London, 1968.
3. AWS- Welding Hand Book. 8th Edition. Vol- 2. "Welding Process"
4. Nadkarni S.V. "Modern Arc Welding Technology", 1st edition, Oxford IBH Publishers, 2005.
5. Christopher Davis. "Laser Welding- Practical Guide". Jaico Publishing House, 1994.

6. Davis A.C., "The Science and Practice of Welding", Cambridge University Press, Cambridge,1993

Experiment wise Measurable students Learning Outcomes:

1. Able to identify and understand various safety aspect of welding.
2. Able to understand different Power source used in Welding with its specific application
3. Able to select electrodes / filler wires used in welding.
4. Able to understand and perform Arc Welding Operation with its application.
5. Able to understand and perform Spot welding Operation and process with its application.
6. Able to understand and perform MIG welding Operation and process with its application.
7. Able to understand and perform gas welding Operation with its application.
8. Able to understand and perform soldering operation with its application.
9. Able to identify and understand various welding defects, causes and their remedies.
10. Able to understand and perform the various DT and NDT methods for weld joints.
11. Able to observe advanced welding processes.

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Title of the Course: Metallurgy **Course Code: UPRD0433**	**L**	**T**	**P**	**Credit**
	0	**0**	**2**	**1**

Course Pre-Requisite:

Fundamental knowledge of crystals structure and meaning of materials, chemistry of Metals and alloys.

Course Description:

Materials science and engineering plays a vital role in this modern age of science and technology. To meet the plant and individual requirements selection of a specific material for a particular use is a very complex process. Metallurgy is the science of materials. The central point of this course is to provide a physical basis that links the structure of materials with their properties, focusing primarily on ferrous and nonferrous metals. With this understanding in hand, the concepts of alloy design and microstructural changes during cooling are also discussed, Heat treating is a group of industrial and metalworking processes as hardening, normalizing and annealing etc. are used to alter the physical, and sometimes chemical, properties of a material.

Course Objectives

- To select proper ferrous or nonferrous metal material as per given application by considering metallurgical and mechanical properties in accordance with its phase diagram with proper justification.
- To explain cooing of any given alloy schematically.
- To calculate percentage of various phases present in solid solution at given temp and composition by using lever rule analytically.
- To draw various types of equilibrium diagrams of Ferrous and Non Ferrous materials, TTT and CCT diagram graphically.
- To clearly distinguish between various types of heat treatment process.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	**Select** proper material for given application by considering metallurgical and mechanical properties with proper justification.	I	Knowledge & skill
CO2	**Explain** cooing of any given alloy *schematically.*	II	Knowledge
CO3	**Interpret** various types of equilibrium diagrams of Ferrous and Non Ferrous materials, TTT and CCT diagram *graphically.*	II	Knowledge
CO4	**Solve** *numerically* percentage of various phases present in solid solution at given temp and composition by using lever rule .	III	Knowledge
CO5	To **apply** core concepts in Materials Science to solve engineering problems.	III	Knowledge
CO6	**Distinguish** between various types of heat treatment process.	IV	Knowledge

CO-PO Mapping:

CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	**2**											
CO2	**2**											
CO3			**2**									
CO4		**2**	**2**									
CO5	**2**											
CO6				**3**								

Assessments :

Teacher Assessment:		
Assessment	Marks	Min for Passing
ISE	25	10
ISE based on assignment/declared test/Moodle quiz/Topic seminar/Group Discussions, Industrial case study etc.		

Course Contents:	
Experiment No.1 Study of Metallurgical microscope and Metallography **Outcome:** To handle Metallurgical microscope physically and independently and to cary out specimen preperation	**2 hrs**
Experiment No.2 Study of microstructure of hypo eutectoid, Eutectoid steel and Hypereutectoid steels **Outcome:** To differentiate among types of steels by observing their respective microstructures and Fe-Fe_3C diagram	**2 hrs**
Experiment No.3 Study of microstructure of cast iron as SG, Gray, White, Chilled, Malleable Cast Irons **Outcome:** To differentiate among types of cast irons by observing their respective microstructures and Fe-Fe_3C diagram	**2 hrs**
Experiment No.4 Study of microstructure of Non-ferrous alloys as Brass, Bronze, Babbits **Outcome:** To differentiate among types of Cu, Al, Mg, Pb, Sn based alloys by observing their respective microstructures and phase diagram	**2 hrs**
Experiment No.5 Tensile test of MS, Al and Brass material **Outcome:** To interpret mechanical properties of ferrous and non ferrous materials.	**2 hrs**
Experiment No.6 Izod and charpy impact test of MS, Al and Brass material **Outcome:** To interpret mechanical properties of ferrous and non ferrous materials.	**2 hrs**
Experiment No.7 Study of Normalizing, Annealing and Hardening heat treatment **Outcome:** To carry out Normalizing, Annealing and Hardening heat treatment with help of TTT Diagram	**2 hrs**
Experiment No.8 Study of Hardenability of steel **Outcome:** To interpret meaning and importance of Hardenability of steel.	**2 hrs**
Experiment No.09 Study of heat treatment furnaces. **Outcome:** To study different types of Furnaces and to select a proper furnace a per given condition and application	**4 hrs**
Experiment No.10 Industrial Visit **Outcome:** To study different heat treatment processes	**4 hrs**

Textbooks:

1. Vijendra Singh. Engg. Physical Metallurgy, Standard Publishers, Delhi
2. V.D. Kodgire, Material science and metallurgy, Everest Publishers Pune
3. T.V. Rajan & C.P. Sharma, Heat Treatments Principles & Practices, PHI.
4. A.K. Sinha, Powder Metallurgy
5. Phase transformation in metals and alloys by K.E Easterling, D.A. Poater, Chapman & Hall, 1992.
6. Structure & properties of alloys: the application of phase diagrams to the interpretation and control of industrial alloy structures by Brick, Gordon and Phillips, McGraw-Hill.
7. Heat treatment of metals by Vijendra Singh, Standard Publishers Distributors, 2006.

References:

1. S.H.Avner, Physical Metallurgy, TMH publication.
2. Rollson , Metallurgy for Engg. Technicians, English language Book Society
3. Higgins R. A., Hodder, Engineering Metallurgy I and II, English language Book Society.
4. Prabhudev, Heat treatment of Steels, HMT Handbook

5. G.E. Dieter, Mechanical Metallurgy, Tata McGraw-Hill, New Delhi.
6. Engineering Physical Metallurgy - Lakhtin, C.B.S. Publishers & Distributors
7. Heat treatment of Metals – B. Zaharov, C.B.S. Publishers & Distributors India
8. Material science and Metallurgy, C. Daniel Yesudin, D. G. Harris Samuel Scitech
9. Material Science And Engineering , Callister Wiley India Edition
10. ASM Handbooks, American Society of Metals

Exeriment wise Measurable students Learning Outcomes:

[1]	Able to handle metallurgical microscope physically and independently and to cary out specimen preperation
[2]	Able to differentiate among types of steels by observing their respective microstructures and Fe-Fe_3C diagram
[3]	Able to differentiate among types of cast irons by observing their respective microstructures and Fe-Fe_3C diagram
[4]	Able to differentiate among types of Cu, Al, Mg, Pb, Sn based alloys by observing their respective microstructures and phase diagram
[5]	Able to interpret mechanical properties as TS; yield strength etc. of ferrous and non ferrous materials.
[6]	Able to interpret mechanical properties as toughness of ferrous and non ferrous materials.
[7]	Able to carry out Normalizing, Annealing and Hardening heat treatment with help of TTT Diagram
[8]	Able to interpret meaning and importance of Hardenability of steel.
[9]	Able to study different types of Furnaces and to select a proper furnace a per given condition and application
[10]	Able to study different heat treatment processes

Title of the Course: Theory of Machines – Lab.	L	T	P	Credit
Course Code: UPRD0434	0	0	2	1

Course Pre-Requisite:

Prerequisite for the course is completion of course of Applied Mechanics and Engineering Mathematics. Fundamentals of engineering mechanics including forces acting on bodies at rest, free body diagram, determination of equilibrium equations, differentiation and integration. In addition, the students should have adequate knowledge about graphical skills and analytical skills.

Course Description:

Theory of Machines is a fundamental course for Production engineers to understand the working principles of any machine. This course is essential to understand the motion, transmission of the motion and the forces responsible for the motion. The major focus is on determination of displacement, velocity & acceleration of different links of the mechanisms using Graphical method Also the course is intended to build up necessary background for understanding the dynamic behavior of machines. It focuses on the Balancing of rotary and reciprocating masses, Gyroscope, Basics of vibrations, free undamped and damped vibration, forced vibration. Apart from above, study of simple mechanisms, Brakes and Dynamometer, study of governors, toothed wheels and gear train are the major contents of the syllabus.

Course Objectives:

1. To be familiar with common mechanisms used in machines and everyday life.
2. Determine M.I of irregular shape bodies experimentally
3. To identify and investigate the stability of spinning bodies due to gyroscopic effect.
4. To apply the theoretical knowledge to balance the rotary systems.
5. To determine natural frequency, damped frequency and resonant frequency of any vibratory system.
6. To recognize the whirling speed conditions of shaft and methods to eliminate it.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Define various terminologies related to kinematics of gear, gear train, flywheel and gyroscope.	1	Knowledge
CO2	Explain the function of governor and flywheel.	2	Knowledge
CO3	Describe basic elements of gear design and motion analysis and selection of gear and gear trains.	2	Knowledge
CO4	Calculate the balancing masses for rotary and reciprocating disturbing masses.	3	Knowledge
CO5	Analyze simple dynamic systems.	4	Knowledge

CO-PO Mapping:

CO	1	2	3	4	5	6	7	8	9	10	11	12
CO1				2								3
CO2			3									3
CO3				2								3
CO4		3										3
CO5		2	1									3

Assessments :

Teacher Assessment:

One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

Assessment	Marks
ISE	50
ESE	50

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.

ESE: Assessment is based on oral examination

Course Contents:

Experiment No. 1:--- Study of machine and mechanisms. **Aim and Objectives:** Introduce students to machine, mechanism etc. **Theoretical Background:** Introduction to Theory of Machines – I Unit –I theory **Experimentation:** Working models of mechanisms and inversions.	**2 Hrs.**
Experiment No. 2:--- Velocity analysis. - By Instantaneous Center method and relative Velocity method **Aim and Objectives:** To Determine the velocities of links of mechanism **Outcomes: Explain** the basic relation between time, velocity and acceleration for mechanisms. **Theoretical Background:** Velocity Analysis by Instantaneous center method **Experimentation:** One A3 size sheet of problems on Instantaneous Center Method. **Conclusion:** Calculate the velocity of a point on four link mechanism	**4 Hrs.**
Experiment No. 3:--- Study of free longitudinal Vibrations **Aim and Objectives:** Determine the natural frequency of helical spring. **Outcomes:** Calculate natural frequency theoretically and through experiment **Theoretical Background:** Vibration, Types . **Experimentation:** Determination of frequency by longitudinal vibrations **Results and Discussions:** comparison of theoretical and experimental results. **Conclusion:**	**2 Hrs.**

Experiment No. 4:--- Study of Trifillar Suspension **Aim and Objectives:** To study the method to find M.I. of a body **Outcomes:** Determine M.I of irregular shape bodies experimentally **Theoretical Background:** Transverse vibration, M.I. equation for given body **Experimentation:** Calculate natural frequency of trifillar suspension **Results and Discussions:** comparison of theoretical and experimental results **Conclusion:**	**2 Hrs.**
Experiment No. 5:--- Study of Gyroscope **Aim and Objectives:** Study gyroscopic effect **Outcomes:** Gyroscopic couple calculation **Theoretical Background:** Gyroscope and its effect. **Experimentation:** Study gyroscopic effect by applying external force to spinning body in equilibrium **Results and Discussions:** comparison of theoretical and experimental results **Conclusion:**	**2Hrs.**
Experiment No. 6:--- Experiment on Static and Dynamic Balancing **Aim and Objectives:** Balancing of masses in different planes. **Outcomes:** balancing of disturbing masses. **Theoretical Background:** Centrifugal Force due to disturbing mass and moment. **Experimentation:** Balancing of two masses rotating in different planes with another two masses rotating in planes. **Results and Discussions:** comparison of theoretical and experimental results **Conclusion**	**4 Hrs.**
Experiment No. 7:--- Study of Whirling Speed of shaft **Aim and Objectives:** Study of critical speed **Outcomes:** **Theoretical Background:** Whirling speed and its effect due to centrifugal force. **Experimentation:** **Results and Discussions:** **Conclusion**	**2 Hrs**
Textbooks: 01. Theory of Machines and Mechanisms, by P. L. Ballaney, (Khanna Publishers, Delhi) 02. Theory of Machines, by S. S. Ratan, (TMH) 03. Theory of Mechanism and Machines by Ghosh and Mallik (EWP) 04. Theory of machines, by Dr. R.K.Bansal, Laxmi Publication 05.Theory of Machines by R.S. Khurmi S.Chand and co. 06. Theory of Machines, by Thomas Bevan, (CBS Publishers, Delhi)	
References: 01. Theory of Machines and Mechanisms, by John Uiker, Garden Pennock & Late. J. F.	

Shigley,

(Mc Graw Hill Publications)

02. Theory of Machines, by W. Green,

03. Mechanical vibrations G.K. Grover

04. Mechanical Vibration Analysis- P.Srineevasan- Tata McGraw Hill

05. Theory and Practice of mechanical vibrations J.S.Rao K.Gupta – New Age International Publications.

06. "Machines and Mechanisms Applied Kinematic Analysis", David H. Myszka, Pearson Education, Asia.

07. "Design of Machinery", R. L. Norton, McGraw-Hill.

08.Theory of vibrations with applications- W.T.Thompson-Prentice Hall of India

09. Mechanical Vibrations- Schaum's outline series- McGraw Hill

Experiment wise Measurable students Learning Outcomes:

1	Study of machine and mechanisms	Students will be able to identify various Mechanisms and their inversions
2	Velo Velocity analysis. - By Instantaneous Center method and relative Velocity method	Students will be able to calculate velocity and acceleration of a given mechanism.
3	Study of free longitudinal Vibrations	Students will be able to calculate natural frequency Of Longitudinal vibrations theoretically and Experimentally.
4	Study of Trifillar Suspension	Students will be able to calculate radius of gyration Of a given component.
5	Study of Gyroscope	Students will be able to study the gyroscopic effect
6	Experiment on Static and Dynamic Balancing	Students will be able to balance the system .

7	Study of Whirling Speed of shaft	Students will study the whirling speed in a rotating Shaft and its effect.

Title of the Course: Workshop Practice – III	L	T	P	Credit
Course Code: UPRD0435	-	-	2	1

Course Pre-Requisite:

4. Fundamentals of drawing
5. Fundamentals of machine tool processes
6. Fundamentals of cutting processes

Course Description:

The workshop training aims at providing practical experience in production of components as well as knowledge and understanding about materials and their machining and finishing. The machine shop is the heart and soul of Production engineering branch. It deals with the various machining operations such as turning, milling, grinding, shaping, thread cutting, drilling etc.

Course Objectives:

2. To practice basic metal cutting processes and enhance the skills.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	Explain basic metal cutting processes performed on drilling, grinding and milling machine	2	Explain
CO2	Demonstrate turning of given concentric and eccentric profile on Lathe machine	2	Demonstrate
CO3	Perform metal cutting operations on parts of an assembly on lathe, milling, drilling and grinding machines as per specified part drawings	5	Perform
CO4	Organize the different machined parts to form an assembly	3	Organize

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1													
CO2		2												
CO3				2										
CO4						2		2				2		3

Assessments :

Teacher Assessment:

Assessment	Marks
ISE	25
ESE (P.O.E)	25

ISE: Assessment is based on 100% lab work

ESE: Assessment is based on 100% lab work.

Practical examination of Six hours duration should be conducted under the supervision of external examiner and should consist of preparation of job involving operations based on Workshop Practice-III and workshop practice-IV and the assessment of the job by the external examiner.

Course Contents:

Lab section 1:Introduction to basic operations and tools	**2 Hrs.**
Lab section 2: Drawing reading and process sequence	**2 Hrs.**
Lab section 3: One composite job consisting of three to four parts employing following operations such as turning, profile turning, eccentric turning, milling, grinding, shaping, thread cutting, drilling.	**20 Hrs.**

Note:-

1) Students should prepare setup wise working drawing showing all the details in work diary.
2) Dimensional accuracy is of prime importance.
3) Student must maintain work diary showing regular progress in the semester.

Textbooks:

1. Workshop Technology Vol. I & II by Hajra Chaudhary, (Media Promoters & Publishers Pvt. Ltd.)
2. Workshop Technology Vol. I , II and III by W.A.J. Chapman, (ELBS)
3. Workshop Technology Vol. II by Bawa H. S. (TMH)
4. A Course on Workshop Technology – Vol. 1 by B. S. Raghuvanshi; (Dhanpat Rai & Co.)
5. Workshop Technology Vol. III – Chapman (ELBS)

Experiment wise Measurable students Learning Outcomes:

5. Student shall be able to explain basic machining operations
6. Student shall be able to decide process sequence
7. Student shall be able to perform turning, profile turning, eccentric turning, milling, grinding, shaping, thread cutting, drilling operation