

REVISED CURRICULUM
OF
DIPLOMA OF ASSOCIATE ENGINEER
IN
MECHANICAL TECHNOLOGY
(THIRD YEAR)

Revised Scheme of Studies D.A.E. 3RD Year Mechanical

Code		Subject	Hrs	T	P	C
Gen	311	Islamiat and Pak Studies	32	1	0	1
REVISED SUBJECTS						
IMH	311	Industrial Management and Human Relations	32	1	0	1
Mech.	312	Hydraulics and Hydraulic Machines	128	1	3	2
Mech.	323	Applied Thermodynamics	128	2	3	3
Mech.	331	Industrial Planning and Production	32	1	0	1
Mech.	343	Machine Design	160	2	3	3
Mech.	353	Tool& Mould Design	160	2	3	3
Mech.	362	Materials Testing and Heat Treatment	128	1	3	2
Mech.	374	Workshop Practice – III	256	2	6	4
NEW SUBJECTS						
Mech.	382	CAD/CAM	128	1	3	2
Mech.	392	CNC Machines	128	1	3	2
TOTAL				15	27	26

Gen-311

ISLAMIAT AND PAKSTUDY

اسلامیات / مطالعہ پاکستان

نصاب (سال سوم)

حصہ اول اسلامیات Gen 311 ٹی پی سی
1 0 1

حصہ دوم مطالعہ پاکستان

کل وقت 20 گھنٹے

موضوعات

- 1 قرآن مجید
سورة الفاتحة۔ آية الكرسي۔ سورة البقرة کی آخری آیات از امن الرسول تا آخر سورة اخلاص
معہ ترجمہ و تشریح
- 2 دس منتخب احادیث معہ ترجمہ و تشریح
- بنی الاسلام علی خمس شہادۃ ان لا الہ الا اللہ و اقام الصلوۃ و ایتاء
الزکوۃ و حج البيت و صوم رمضان
- الدین النصیحہ
- المستشار الموتمن
- للمومن علی المومن ست خصال یعودہ اذا مرض و یشمتہ اذا مات
و یجیبہ اذا دعاہ و یسلم علیہ اذا لقیہ و یشمت اذا عطس و ینصح لہ
اذا غاب او شہد لا تخن من خانک
- لا یدخل الجنة قاطع
- ان اللہ حرم علیکم عقوق الامہات و اضاعة المال
- یسرا و لا تعسرا بشراً و لا تنفرا
- ذاق طعم الايمان من رضی باللہ و بالاسلام دینا و بمحمد نبیا
- افضل الذکر لا الہ الا اللہ
- 3 حقوق و فرائض
حصول تعلیم بطور فرض ، والدین اور اولاد کے حقوق و فرائض ، ہمسایہ کے حقوق
- 4 اسلام کی اخلاقی اقدار
صبر و استقلال۔ غفور و درگزر۔ ایقانے عہد۔ اخوت۔ ایثار و قربانی

ٹی	پی	سی	(غیر مسلم طلباء کے لئے)	نصاب اخلاقیات
1	0	1	Gen-311	سال سوم
کل وقت 20 گھنٹے			<u>موضوعات</u>	

- احساس ذمہ داری
- مثبت ذہن
- عدل و انصاف
- قومی خدمت کا جذبہ
- فکر و نظر کی پاکیزگی
- احترام آدمیت
- شائستگی
- غفو و درگزر
- بردباری
- خود انحصاری
- اثر و نفوذ
- جامعیت
- اپنی ذات کی معرفت (بذریعہ ہم عصر طلباء۔ اساتذہ۔ اہم شخصیات، ادارہ)

منتخب احادیث

عمومی مقصد۔ احادیث کی روشنی میں اسلامی تعلیمات پر عمل پیرا ہو سکے۔

خصوصی مقاصد

احادیث کا ترجمہ بیان کر سکے۔

احادیث کی تشریح کر سکے۔

معاشرتی اور انفرادی زندگی میں احادیث سے راہنمائی حاصل کر سکے۔

حقوق و فرائض

عمومی مقصد۔ اسلامی معاشرے کا ایک اچھا فرد بن سکے۔

خصوصی مقاصد

والدین کے حقوق و فرائض بیان کر سکے۔

ہمسایوں کے حقوق بیان کر سکے۔

اسلام میں حقوق و فرائض کی اہمیت بیان کر سکے۔

حقوق و فرائض کی آگاہی کی صورت میں اپنے اندر خدمت خلق کا جذبہ پیدا کر سکے۔

اسلامی اقدار

عمومی مقصد۔ طالب علم:

جان سکے گا کہ تعلیم کا مقصد حسن اخلاق سے متصف ہونا ہے

خصوصی مقاصد

اخلاق کے معنی و مفہوم کو بیان کر سکے۔

اسلام میں حسن اخلاق کی اہمیت بیان کر سکے۔

قرآن و سنت کی روشنی میں صبر و استقلال کی اہمیت بیان کر سکے۔

اسلام میں عفو و درگزر کی اہمیت بیان کر سکے۔

ایفائے عہد کی اہمیت بیان کر سکے۔

اخوت کے معنی و مفہوم کو بیان کر سکے۔

اخوت اسلامی کی اہمیت بیان کر سکے۔

اسلام کی اعلیٰ اقدار کو اپنا کر مثالی معاشرہ پیدا کر سکے۔

نصاب (سال سوم)
مطالعہ پاکستان

Gen-311

ٹی پی سی
1 0 1

حصہ دوم

کل وقت 12 گھنٹے

قیام پاکستان

موضوعات

- باؤنڈری کیپشن
- ریڈ کلف ایوارڈ
- تقسیم بنگال و کلکتہ
- تقسیم پنجاب
- مسئلہ مہاجرین
- ریاستوں کا الحاق
- ریاست جموں و کشمیر
- نہری پانی کا تنازعہ
- قرارداد مقاصد
- علماء کے بائیس نکات
- 1956 - 1962 اور 1973 کے دستاویز کی اسلامی دفعات
- پاکستان کا محل وقوع اور اس کی جغرافیائی اہمیت
- قدرتی وسائل (تیل، گیس، کوئلہ)

مطالعہ پاکستان

حصہ دوم

قیام پاکستان

تدریسی مقاصد

عمومی مقصد قیام پاکستان کے بعد درپیش مسائل سے آگاہی حاصل کرے اور بیان کرے۔

خصوصی مقاصد

- باؤنڈری کمیشن کی تشکیل اور اس کے فرائض بیان کر سکے۔
- ریڈ کلف اور اس کے ایوارڈ کے بارے میں بیان کر سکے۔
- بنگال اور کلکتہ کی تقسیم کی وجوہات بیان کر سکے۔
- پنجاب کی تقسیم کی تفصیل بیان کر سکے۔
- مہاجرین کی آمد سے جو مسائل پیدا ہوئے انہیں بیان کر سکے۔
- ریاستوں کے الحاق کے بارے میں تفصیل بیان کر سکے۔
- ریاست جموں کشمیر کے بارے میں بیان کر سکے۔
- نہری پانی کے تنازعہ کو بیان کر سکے۔
- قرارداد مقاصد کی تفصیلات بیان کر سکے۔
- 22 علماء کے متفقہ اسلامی نکات بیان کر سکے۔
- قیام پاکستان کے بعد نفاذ اسلام کی کوششوں کو بیان کر سکے۔
- پاکستان کے محل وقوع اور اس کی جغرافیائی اہمیت بیان کر سکے۔
- پاکستان میں قدرتی وسائل (تیل، گیس، کوئلہ) کے بارے میں بیان کر سکے۔

IMH-311
INDUSTRIAL MANAGEMENT
AND HUMAN RELATIONS

Total Contact Hours	T	P	C
Theory 32	1	0	1

AIMS The study of this subject will enable the student to develop the management skill, acquaint him with the principles of management and human relations and develop psychological approach to solve the labor problems

Course Contents:

1. Industrial Psychology	2 Hrs
2. Industrial Management	2 Hrs
3. Planning	3Hrs
4. Human Resource Management	2 Hrs
5. Industrial Fatigue and Boredom	2 Hrs
6. Industrial Prejudice	2 Hrs
7. Human Relations	3Hrs
8. Job Evaluation	3 Hrs
9. Leadership	2Hrs
10. Motivation	2 Hrs
11. Guidance and Counseling	2Hrs
12. Working Conditions	2 Hrs
13. Budget as Controlling Technique	3Hrs
14. Role of <u>middle man</u> in Management	2 Hrs

Detail of Contents:

1. Industrial Psychology	2 Hrs
1.1 History and definition	
1.2 Application and Importance	
2. Industrial Management	2 Hrs
2.1 Introduction	
2.2 Functions of management	
2.3 Subdivisions of management	
2.4 Objectives of industrial management.	
2.5 General principles of management	
3. Planning	3Hrs
3.1 Definition	
3.2 Steps of Planning	
3.3 Advantages	

4. Human Resource Management	2 Hrs
4.1 Recruitment and orientation of employees	
4.2 Training	
4.3 Effects of training on production and product cost	
5. Industrial Fatigue and Boredom	2 Hrs
5.1 Definition and distinction	
5.2 Psychological causes	
5.3 Objective causes	
5.4 Prevention	
6. Industrial Prejudice	2 Hrs
6.1 Causes and Effects	
6.2 Remedies	
7. Human Relations	3 Hrs
7.1 Importance and Roles	
7.2 Functions	
8. Job Evaluation	3 Hrs
8.1 Importance	
8.2 Job description and specification	
8.3 Performance evaluation and job satisfaction	
8.4 Work simplification	
9. Leadership	2Hrs
9.1 Definition and types	
9.2 Qualities of a good leader	
10. Motivation	2 Hrs
10.1 Definition	
10.2 Types	
10.3 Conflict of motives	
10.4 Effects of motivation on morale	
11. Guidance and Counseling	2 Hrs
11.1 Importance	
11.2 Choice of job	
11.3 During service	
12. Working Conditions	2 Hrs
12.1 Importance and consideration	
12.2 Effects on efficiency and per unit cost	
13. Budget as Controlling Technique	3Hrs
13.1 Definition	
13.2 Types	
13.3 Importance	
14. Role of middle man in Management	2 Hrs
14.1 Foreman /Supervisor's abilities	
14.2 Duties and functions	

Recommended Textbooks:

- 1. Industrial Psychology by C.S. Meyers (Publisher: Oxford University Press, London)**
- 2. Psychology of Industrial Behaviors by Smith Wakley (Publisher: Mc-Graw Hill, New York)**
- 3. The Process of Management by Andrew R. Megill (Publisher : William M New Man)**
- 4. Management of Industrial Enterprises by Richard N Omen**

Instructional Objectives:

At the completion of this course, the students will be able to:

- 1. Know Industrial Psychology**
 - 1.1 Describe brief history of industrial psychology
 - 1.2 Describe in detail definition of industrial psychology
 - 1.3 State application and important of industrial psychology
- 2. Understand Industrial Management**
 - 2.1 Define management
 - 2.2 State functions of management
 - 2.3 Enlist subdivision of management
 - 2.4 Explain objectives of industrial management
 - 2.5 Explain general principles of management
- 3. Understand Planning**
 - 3.1 Define planning
 - 3.2 Describe step of planning
 - 3.3 Describe advantages of planning
- 4. Understand Human Resource Management**
 - 4.1 Describe the recruitment procedure of employees in an industrial concern
 - 4.2 Explain training
 - 4.3 Identify the kinds of training
 - 4.4 Explain the effects of training on production and product cost
- 5. Understand Industrial Fatigue and Boredom**
 - 5.1 Define fatigue and boredom
 - 5.2 Describe psychological causes of fatigue and boredom
 - 5.3 Describe objective causes of fatigue and boredom
 - 5.4 Explain measures to prevent fatigue and boredom
- 6. Understand Industrial Prejudice**
 - 6.1 Define prejudice
 - 6.2 Explain causes and effects of industrial prejudice
 - 6.3 Explain remedies of industrial prejudice
- 7. Understand the Human Relations**
 - 7.1 Explain importance and role of public/human relations
 - 7.2 Explain functions of public/human relations
- 8. Understand Job Evaluation**
 - 8.1 Explain importance of job evaluation
 - 8.2 Explain job description and job specification
 - 8.3 Explain performance evaluation and job satisfaction
 - 8.4 Explain work simplification

9. Know Leadership

- 9.1 Define leadership
- 9.2 Describe types of leadership
- 9.3 State qualities of a good leader

10. Understand Motivation

- 10.1 Define motivation
- 10.2 Describe financial and non financial motives
- 10.3 Explain conflict of motives
- 10.4 Explain effects of motivation on moral

11. Understand the Need for Guidance and Counseling

- 11.1 State importance of guidance and counseling
- 11.2 Explain the role of guidance and counseling in choosing the job
- 11.3 Describe help of guidance and counseling during service

12. Understand the Effects of Working Conditions on Efficiency

- 12.1 Explain importance of working conditions
- 12.2 Describe air-conditioning, ventilation, lighting and noise
- 12.3 State the effects of good working conditions on efficiency and per unit cost

13. Understand Budget as Controlling Techniques

- 13.1 Explain budget as controlling techniques
- 13.2 Explain types of budgets
- 13.3 Explain the importance of budget as controlling technique

14. Understand the Role of Middle man in Management

- 14.1 Explain abilities of a foreman / supervisor
- 14.2 Enlist duties of foreman / supervisor
- 14.3 Describe functions of foreman as middle management

Mech-312

HYDRAULICS AND HYDRAULIC MACHINES

Mech-312

HYDRAULICS AND HYDRAULIC MACHINES

Total Contact Hrs.		T	P	C
Theory	32	1	3	2
Practical	96			

AIMS: At the end of the course the students will be able to understand properties of incompressible fluids, pressure and flow of fluids, able to apply problems of total head of water for losses of heads etc. The student will be able to know the Introduction to water wheels, hydraulic turbines, pumps and, hydraulics machines. Knowledge of essential parts of hydraulic circuits, types of Actuators, their applications & maintenance, Knowledge of different types of directional control valves used in hydraulic control / circuits. The student will also be able to study hydraulic circuits of different machines & can rectify their basic faults

Course Contents:

1. Introduction to hydraulics	3 Hrs
2. Hydro kinetics	3Hrs
3. Flow Through Pipes	4 Hrs
4. Impact of Jet	1 Hr
5. Water Turbines	2 Hrs
6. Pumps	4Hrs
7. Hydraulic Valves and Seals	3Hrs
8. Hydraulic machines	4Hrs
9. Hydraulic Actuators	4Hrs
10. Hydraulic Circuits and Accessories	4Hrs

Detail of Contents:

1. Introduction to Hydraulics	4 Hrs
1.1 Introduction to hydraulics	
1.2 Introduction to different properties of liquids(Water & oils)	
1.2.1 Care of Hydraulic liquids	
1.3 Density of liquids	
1.3.1 Specific weight of liquids	
1.3.2 Specific gravity of liquids	
1.4 Viscosity of liquids, S.I. Units of Viscosity, Relation of change of viscosity with the change of temperature	
1.4.1 Difference between Hydraulic & Lubricating oils	
1.4.2 Effects of viscosity on flow of liquids	
1.5 Pressure head of liquids, Conversion of intensity of pressure in head of liquid	
1.6 Pascal's law	
1.7 Pressure and its Types, Atmospheric pressure, Gauge pressure, Absolute pressure,	

- 1.8 Measurement of pressure with,
 - 1.8.1 Piezo-meter tube
 - 1.8.2 Pressure gauges(Bourdon tube pressure gauge, Diaphragm pressure gauge)
 - 1.8.3 Dead weight pressure gauge calibrator
 - 1.8.4 Calibration of pressure Gauges with Dead Weight pressure& master Gauge calibrator
- 1.9 Solution of simple problems on above topics
- 2. Hydro Kinetics 3 Hrs**
 - 2.1 Introduction
 - 2.2 Rate of discharge
 - 2.2.1 Equation of discharge(volume, weight, mass)
 - 2.3 Equation of continuity of flow
 - 2.4 Total energy/head of liquid particles in motion
 - 2.5 Bernoulli's Equation
 - 2.5.1 Limitations of Bernoulli's Equation
 - 2.5.2 Application of Bernoulli's Equation
 - 2.6 Types of flow
 - 2.7 Use of Pitot-tube gauge for measurement of velocity and discharge of flowing fluids
 - 2.8 Solution of simple problems of discharge, Velocity head, pressure head, Datum head intensity of pressure in flowing liquid when all parameter are given
 - 2.9 Flow meter (Venturi meter and orifice meter]
- 3. Flow through pipes 3 Hrs**
 - 3.1 Introduction to losses of head in pipes
 - 3.1.1 Reynold's Number for internal flow
 - 3.2 Loss of head of liquid flowing in pipe (major & minor losses)
 - 3.2.1 Losses of head due to friction
 - 3.2.2 Loss of head due to sudden enlargement
 - 3.2.3 Loss of head due to sudden contraction
 - 3.2.4 Loss of head at entrance in a pipe
 - 3.2.5 Loss of head in bends, elbows, valves & other pipe fittings
 - 3.3 Solution of simple problems by direct application of formulae
- 4. Impact of Jet 1 Hrs**
 - 4.1 Introduction
 - 4.2 Force of Jet normally on fixed plate
 - 4.3 Force of Jet normally on inclined plate
 - 4.4 Force of Jet normally on moving plate
 - 4.5 Force of Jet in series of vanes
 - 4.6 Calculate force of jet in all above cases by application of simple formulae
- 5. Water Turbines 2 Hrs**
 - 5.1 Introduction to Development of water Wheels & water turbines
 - 5.2 Advantages of water turbines over water Wheels
 - 5.3 Classification of water turbines
 - 5.4 Impulse Turbines (Pelton wheel) & its main parts
 - 5.4.1 Working of pelton wheel water Turbine
 - 5.4.2 Sketch a pelton wheel turbine and state main parts
 - 5.5 Reaction turbine and main parts
 - 5.6 Differentiate between Impulse & reaction turbine
 - 5.7 State different types of low head ,high discharge water(Reaction) Turbines
Advantages of hydraulics turbines
- 6. Pumps 4 Hrs**
 - 6.1 Introduction to pump

- 6.2 Types of pumps
 - 6.3 Construction and working of Centrifugal Pumps
 - 6.4 Construction and working of reciprocating pump
 - 6.4.1 Discharge of a single acting reciprocating pump
 - 6.4.2 Slip of a reciprocating pump
 - 6.4.3 Positive Displacement (e.g. Reciprocating , Vane ,Gear etc) pumps
 - 6.5 Comparison of centrifugal and reciprocating pump
 - 6.6 Cavitations in pumps, their causes and remedy
 - 6.7 Solution of simple problems by using above formulae
- 7. Hydraulic valves and Seals 3 Hrs**
- 7.1 Types of Directional control valves, their study, symbols and function
 - 7.2 Pressure relief valves and their types
 - 7.3 Flow control/ Speed control valves & their types
 - 7.4 Study of Pilot operated directional control valves construction, uses and symbols
 - 7.5 Study of Check valves
 - 7.6 Study of Seals used in hydraulics circuits
 - 7.7 Study of Safety Devices necessary in a hydraulic circuits
- 8. Hydraulic Simple Machines 4Hrs**
- 8.1 Types of simple hydraulic machines
 - 8.2 Hydraulic press
 - 8.3 Mechanical advantage of hydraulic press
 - 8.4 Accumulators Their Types and uses in Hydraulic Circuits
 - 8.5 Hydraulic Intensifiers
 - 8.6 Solve simple problems on mechanical advantage of hydraulic press, Accumulators, and Intensifier
- 9. Hydraulics Actuators 4Hrs**
- 9.1 Classification of Rotary Actuators & their method of actuation
 - 9.1.1 Uses of Hydraulic motors
 - 9.1.2 Difference between hydraulic motors & pumps
 - 9.2 Classifications of reciprocating Actuators their construction and working
- 10. Hydraulic Circuits and Accessories 4 Hrs**
- 10.1 The parts/ components of hydraulic circuits
 - 10.2 Uses of proximity switches
 - 10.3 Uses of different hydraulic filters, chillers, different types of rubber hoses, pipe fittings, and couplings

Recommended Textbooks:

1. **Fluid Mechanics by John F. Douglas (Fifth Edition)**
2. **Fluid Mechanics with Engineering Applications by Robert L. Daugherty, Joseph B. Franzini**
3. **Hydraulics and Hydraulics Machines by E.H.LEWITT (Sir ISAAC Pitman & Sons Ltd London)**
4. **Fluid and power with applications by Anthony Esposito**
5. **Basic applied fluid power by Oster Jon**

Instructional Objectives:**1. Introduction to Hydraulics**

- 1.1 Understand basic terms of Hydraulics
 - 1.1.1 Define hydraulics
 - 1.1.2 State difference between liquid and fluid
 - 1.1.3 Enlist properties of liquid (hydraulic oil, lubricating oil etc.)
 - 1.1.4 Define following terms, unit weight of liquids,, viscosity, pressure density, specific gravity
 - 1.1.5 Describe SI units of viscosity, effects of change of viscosity on change of temperature
 - 1.1.5.1 Difference between hydraulic & lubricating oils
 - 1.1.5.2 Effect of viscosity on flow , compression of hydraulic oil and its leakage from hydraulic components (valves & cylinders)
 - 1.1.6 Explain pressure head conversion of hydraulic pressure/ Intensity of Pressure in terms of pressure head
 - 1.1.7 Explain Pascal's law
 - 1.1.8 Describe types of pressure
- 1.2 Understand Pressure Management Techniques
 - 1.2.1 Explain measurement of pressure by simple piezo meter tube and conversion of pressure head in terms of intensity of pressure
 - 1.2.2 Explain diaphragm pressure gauge and bourdon tube pressure gauge
 - 1.2.3 Explain dead weight pressure gauge and calibration procedure of gauges
- 1.3 Solve simple problems of pressure head & intensity of pressure

2. Hydro Kinetics

- 2.1 Understand basic terms of Hydro Kinematics
- 2.2 Describe rate of discharge
- 2.3 Explain equation of continuity of flow
- 2.4 Explain energy/head / total head of a liquid in motion
- 2.5 Explain Bernoulli's Theorem and its applications
- 2.6 Understand types of flow
 - 2.6.1 Describe the types of flow
- 2.7 Describe use of pitot tube in determination of velocity of flowing liquid
- 2.8 Solution of simple problems of discharge, velocity head, pressure head datum head, intensity of pressure in flowing fluid when all parameters are given

3. Flow through pipes

- 3.1 Introduction to loss of head in pipes
- 3.2 Understand Renolds' Number for internal flows
- 3.3 Identify various losses of head of a liquid flowing in pipes (major & minor) and their formula
- 3.4 Explain methods of calculation of Losses of head due to friction
 - a) Chazy's formula (b) Darcy's formula
- 3.5 Explain methods of calculation of loss of head due to sudden enlargement
- 3.6 Explain methods of calculation of loss of head due to sudden contraction
- 3.7 Explain methods of calculation of loss of head at entrance to a pipe
- 3.8 Explain methods of calculation of loss of head in bends elbow valves & other pipe fittings
- 3.9 Solve simple problems for calculation of various losses of head by direct application of formula, when all parameters are given

4. Impact of Jet

- 4.1 Describe Jet of water through nosels
- 4.2 Describe force of jet impinging normally on fixed plate
- 4.3 Describe force of jet impinging on inclined fixed plate
- 4.4 Describe force of jet impinging on moving plate
- 4.5 Solve simple problems based on all above cases

5. Water Turbines

- 5.1 Understand development of water Wheels & water turbines
- 5.2 State advantages and disadvantages of water turbines over water Wheels
- 5.3 State classification of water turbines
- 5.4 Impulse Turbines (Pelton wheel)
 - 5.4.1 Explain working of pelton wheel water turbine
 - 5.4.2 Sketch pelton wheel turbine and state its various parts
 - 5.4.3 Explain Nozzle
 - 5.4.4 Describe Runner and buckets
 - 5.4.5 Describe Casing
 - 5.4.6 Describe Breaking jet mechanism
- 5.5 Understand reaction turbine and its parts
 - 5.5.1 Describe spiral casing
 - 5.5.2 Describe guide vane mechanism
 - 5.5.3 Describe turbine runner
 - 5.5.4 Describe Draft tube
 - 5.5.5 Differentiate between reaction turbine and impulse turbine
- 5.6 State different types of low head, high discharge water Reaction Turbines (Francis Turbine, Propeller Turbine, Kaplan Turbine) and their main parts
 - 5.6.1 Spiral casing
 - 5.6.2 Guide Vane mechanism
 - 5.6.3 Turbine runner
 - 5.6.4 Draft tube
- 5.7 Sketch and study of reaction turbine and label its parts

6. Pumps

- 6.1 State functions of pumps
- 6.2 Describe classifications of pumps
- 6.3 Centrifugal pump
 - 6.3.1 Explain construction of Centrifugal pump
- 6.4 Explain construction and working of reciprocating pump
 - 6.4.1 State simple formula for calculation of discharge of a single acting reciprocating pump ($Q = LAN / 60$)
 - 6.4.2 Explain Slip of a pump
 - 6.4.3 Explain construction of Following Positive Displacement pumps, Reciprocating, Vane, Gear etc.
- 6.5 Compare the centrifugal and reciprocating pump
- 6.6 Cavitations in pumps and their remedy
- 6.7 Solve simple problems by using above formulas

7. Hydraulic valves and Seals

- 7.1 Describe types of hydraulic valves and their symbols
- 7.2 Describe different directional control valves, their construction, types of spools and their symbols
- 7.3 Describe types of pressure relief valves and their symbols
- 7.4 Describe speed control valves/ flow control valve, their construction, uses and symbols
- 7.5 Describe pilot operated directional valves construction, uses and symbols
- 7.6 Describe check valves their types, construction and their symbols

- 7.7 Describe seals used in hydraulic circuits
- 7.8 Describe safety devices used in hydraulic circuits

8. Hydraulic Simple Machines

- 8.1 Describe types of simple hydraulic machines
- 8.2 Explain construction of Hydraulic press
- 8.3 Explain Mechanical advantage of hydraulic press
- 8.4 Explain Hydraulic Intensifiers
- 8.5 Accumulators Their Types and uses in Hydraulic Circuits
- 8.6 Solve simple problems on mechanical advantages of hydraulic press, Hydraulic Intensifier, Hydraulic accumulator

9. Hydraulics Actuators

- 9.1 Describe classification of Rotary Actuators
 - 9.1.1 Explain Use and Construction of different Hydraulic motors
 - 9.1.2 Differentiate between hydraulic motors & pumps
 - 9.1.3 Explain different types of seals used in Hydraulic motors
- 9.2 Describe classifications of reciprocating Actuators
 - 9.2.1 Describe Use of single acting spring return hydraulic cylinder
 - 9.2.2 Describe Use & construction of double acting reciprocating hydraulic cylinder
 - 9.2.3 Describe Use and construction of different hydraulic cylinder & their seals

10. Hydraulic Circuits and Accessories

- 10.1 Parts/ components of hydraulic circuits (Actuator, Control valve, Reservoir, Filter, Pump, pressure control valve, Directional control valve, Hydraulic pipes and couplings, Flow control Valve)
- 10.2 Describe Use of proximity switches
- 10.3 Describe Use of hydraulic filters, chillers, different types of rubber hoses, pipe fittings, and couplings
- 10.4 Describe different hydraulic circuits of hydraulic control machines

List of Practical:

1. Observe hydraulic bench and its function
2. Practice of Calibration of Bourdon tube and diaphragm pressure gauge with dead weight and master gauge calibrator
3. Operate hydraulic press and observe power required to derive it
4. Practice on hydraulic bench for verification of conversion of velocity head, pressure head and datum head
5. Performance test on friction pipe apparatus
6. Performance test for loss of head due to sudden enlargement, contraction and entrance in a pipe using friction in a pipe apparatus
7. Performance test on Impulse turbine /Pelton turbine
8. Performance test on Reaction Turbine /Francis turbine
9. Performance of centrifugal pump at different speed
10. Performance test on reciprocating pump and observe the operation of reciprocating pump
11. Practice of Measurement of pressure at various connections in hydraulic circuits.
12. Actuation of double acting hydraulic cylinder at push of a switch , develop speed regulation through throttle and flow control valves also draw its circuit diagram
13. Actuation of double acting hydraulic cylinder at a Rapid Traverse By using one way Throttle Valve
14. Setup a pressure device on a double acting cylinder by using pressure reducing valve.
15. Practice to hold a specific load by using Double Acting Cylinder & pilot operated Check Valve
16. Construct a circuit for double acting hydraulic(differential cylinder) for mechanical interlocking with switch also draw its Hydraulic & Electric circuit diagram
17. Construct a circuit to control a double acting Hydraulic cylinder, by using O2, push button, and canceling with limit switch/Proximity switch also draw its Hydraulic & Electric circuit diagram
18. Practice to set a Hydraulic motor R.P.M. & direction by using Flow Control & directional Valve
19. To construct a Hydraulic circuit in which Accumulator stored energy can be utilized by double acting cylinder, when required

Practical Objectives

Student will be able to performed explain;

- 1. Observe hydraulic bench and its function**
 - 1.1 Observe pressure head
 - 1.2 Specific gravity of liquid
 - 1.3 Observe the conversion of intensity pressure in to head of liquid and head of liquid in to intensity
 - 1.4 Practice to use simple manometer
- 2. Practice of Calibration of Bourdon tube and diaphragm pressure gauge with dead weight and master gauge calibrator**
 - 2.1 Basic principle use in dead weight pressure calibrator
 - 2.2 Observe the construction of Bourdons tube pressure gauge
 - 2.3 Observe the construction of diaphragm pressure gauge
 - 2.4 Calibration of Bourdon tube pressure gauge and diaphragm pressure gauge with dead weight pressure calibrator
- 3. Operate hydraulic press and observe power required to derive it**
 - 3.1 Work done against a pressure
 - 3.2 Power required for driving a hydraulics press
- 4. Practical application of Hydraulic bench for Conservation of energy of flowing fluid in pressure head an datum head as $H=v^2/2g$**
 - 4.1 Verify the Law of conservation of energy
 - 4.2 Verify total head of liquid
 - 4.3 Bernoulli's theorem and practical application
 - 4.4 Calculate conversion of velocity head, pressure head and datum head
- 5. Performance test on friction pipe apparatus to know total head status of flowing fluid/ Bernoulli's theorem**
 - 5.1 Observe the function of viscosity of liquid, & K.E. of flowing fluid.
 - 5.2 Observe the friction due to roughness of ideal surface as in gauge blocks etc.
 - 5.3 Observe friction due to roughness of pipe
 - 5.4 Measure loss of head in pipes due to friction in pipe apparatus
 - 5.5 Practice of calculation of loss of head due to friction by using friction in pipe apparatus
- 6. Observe behavior of flowing fluid due to sudden enlargement of cross sectional area of pipe, & formation eddies current at enlarged cross section of pipe**
 - 6.1 Observe behavior of liquid at sudden contracted cross sectional area in pipe
 - 6.2 Observe formation of vena contracta beyond contraction (due to sudden enlargement)
 - 6.3 Measure loss of head due to sudden enlargement, contraction and entrance in a pipe using friction in a pipe apparatus
- 7. Perform the function of impulse turbine**
 - 7.1 Observe behavior of water jet at the reduction in cross sectional area at the movement of spear in the nozzle of impulse turbine (pelton wheel)
 - 7.2 Observe function of casing of pelton wheel
 - 7.3 Observe pressure / atmospheric pressure around the water jet and water wheel/ impulse Turbine/ pelton wheel

- 7.4 Observe water hammer at the start and stop of pelton wheel turbine on pipe and hear noise of water hammer on pipe
- 7.5 Observe output HP at the shaft at pelton wheel turbine using purely brake mechanism
- 7.6 Observe the parts of a pelton wheel turbine

8.Performance test on reaction turbine

- 8.1 Operate the reaction turbine
- 8.2 Measure difference of pressure at different position of reaction turbine by pizo meter tube or with Gauges/ dial gauges
- 8.3 Measure in put power at the inlet of Francis turbine
- 8.4 Observe the reaction turbine (Francis turbine)

9.Performance Test on centrifugal force

- 9.1 Observe the different parts of centrifugal pump
- 9.2 Observe the different parts of reciprocating pump
- 9.3 Compare centrifugal pump with reciprocating pump

10.Performance test on positive displacement pump

- 10.1 Measure discharge of reciprocating pump
- 10.2 Verify discharge of reciprocating pump
- 10.3 Measure slip of reciprocating pump
- 10.4 Observe the parts of reciprocating pump

11.Practice of measurement of pressure at various connections in hydraulic circuit

- 11.1 Perform the function of temperature gauge at oil reservoir/oil tank in a circuit
- 11.2 Perform the function of oil filter in hydraulic Circuit
- 11.3 Observe all safety devices which necessary in a hydraulic circuit
- 11.4 Observe the necessity of pressure relief valve in hydraulic circuit
- 11.5 Measure pressure at various positions in hydraulic circuit
- 11.6 Draw block/ circuit diagram of a Hydraulic circuit
- 11.7 Uses and positions of directional control valve in a Hydraulic circuit
- 11.8 Use, position & necessity of non-return valve in a Hydraulic circuit
- 11.9 Set the equipment into the test panel
- 11.10 Check all the connections houses are firmly coupled
- 11.11 Practice of determination of pressure at various connections to the driven elements and direction of flow depending different settings of directional control valve

12.Actuation of double acting hydraulic cylinder at push of a switch ,develop speed regulation through throttle valve and flow control valves

- 12.1 Measure pressure at various positions in hydraulic circuit
- 12.2 Draw block/ circuit diagram of a Hydraulic circuit
- 12.3 Uses and positions of directional control valve in a Hydraulic circuit
- 12.4 Use, position & necessity of non-return valve in a Hydraulic circuit
- 12.5 Set the equipment into the test panel
- 12.6 Check all the connections houses are firmly coupled
- 12.7 Practice of determination of pressure at various connections to the driven elements and direction of flow depending different settings of directional control valve

13.Actuation of double acting hydraulic cylinder at a rapid Traverse by using one way Throttle Valve

- 13.1 Make sure the pump is switched off and oil is not in pressure at the coupling/ fitting stage
- 13.2 Set the equipment into the test penal
- 13.3 Connect the units according to the circuit diagram with connection Hoses
- 13.4 Check all the connection Hoses firmly coupled
- 13.5 Carry out the experiment as rapidly as possible to keep the overheating of oil during practical (not more than 45°C)

- 13.6 Observe the function of Throttle Valve and draw Circuit Diagram
- 13.7 Observe the function by extending a double acting hydraulic cylinder at push of a switch develop speed regulation through throttle and flow valves
- 14. Setup a pressure device on a double acting cylinder by using pressure reducing valve**
 - 14.1 Observe the function of Pilot operated Check Valve
 - 14.2 Observe the sequence of Elements used in circuit
 - 14.3 Observe the Function of Pressure Relief valve, know function of Non Return Valve in this Circuit Diagram
 - 14.4 Mount the various units in the test panel according to the layout/circuit diagram
 - 14.5 Connect the circuit with Pressure Houses
 - 14.6 Connect the cylinder and measure Inlet and Outlet Pressure on Pump
 - 14.7 Set the throttle check valve
 - 14.8 Draw Hydraulic circuit diagram for this Practical
 - 14.9 Check rapid Traverse of cylinder at return of stroke and complete this practical
- 15. Practice to hold a specific load by using double acting cylinder and pilot operated check valve**
 - 15.1 Mount various components in the test panel
 - 15.2 Check/set sequence of components 3/2 and 4/2 directional control valve, pressure relief valve and pilot operated chuck valve
 - 15.3 Draw circuit diagram for the circuit I conduct the experiment according to the circuit diagram
- 16. Construct a circuit for double acting cylinder for mechanical interlocking with switch contacts also draw its circuit diagram**
 - 16.1 Arrange the components/valve in the test panel as per circuit diagram
 - 16.2 Observe what is Mechanical interlocking with switch contacts
 - 16.3 Draw circuit diagram for the circuit & conduct the experiment according to the circuit diagram Complete the experiment
- 17. Construct a circuit to control a double acting hydraulic cylinder , by using O2 , push button, and canceling with proximity limit switch**
 - 17.1 Observe the types of limit switches/proximity switches (conductive, capacitive & optical) used in a hydroelectric circuit
 - 17.2 Observe what is the function of two hand safety circuit?
 - 17.3 Draw a Hydraulic circuit diagram to connecting a double acting Hydraulic cylinder using push button, direction hold in circuit and connecting with limit switch using two hand electrical pushbutton safety circuit
 - 17.4 Draw circuit diagram for the circuit & conduct the experiment according to the circuit diagram Complete the experiment
- 18. Practice to set a hydraulic motor R.P.M & direction by using Flow Control & Directional valve**
 - 18.1 Practice the use of a direction control valve changes the direction of rotation of a hydraulic motor
 - 18.2 Observe that how we can change the velocity of hydraulic motor by using throttle valve
 - 18.3 Draw circuit diagram for the circuit & conduct the experiment according to the circuit diagram Complete the experiment
- 19. To construct a hydraulic circuit in which Accumulator stored energy can be utilized by double acting cylinder , when required**
 - 19.1 Observe the types of accumulators
 - 19.2 How much we can store energy in an accumulator
 - 19.3 Draw circuit diagram for the circuit & conduct the experiment according to the circuit diagram Complete the experiment

List of Machinery:

1.	Fluid friction in pipes with hydraulic bench	2-set
2.	Bernoulli's Theorem Demonstration Apparatus	2
3.	Orifice Discharge Apparatus	2
4.	Apparatus of Energy Losses in Pipes	2
5.	Centrifugal Pump Apparatus	1
6.	Axial Pump Apparatus	1
7.	Reciprocating Pump Apparatus	1
8.	Pelton Turbine	1
9.	Reaction Turbine	1
10.	Hydraulic Control Equipment Set	1
11.	Gear Pump (Transparent Model)	1
12.	Vane Pump (Transparent Model)	1
13.	Axial Piston Pump (Transparent Model)	1
14.	Pressure Gauge (Transparent Model)	1
15.	Pressure Relief Valve (Transparent Model)	1
16.	Pressure Switch (Transparent Model)	1
17.	Piston Accumulator (Transparent Model)	1
18.	Dead Weight Master Gauge Calibrator	1

Mech-323
APPLIED THERMODYNAMICS

Mech-323**APPLIED THERMODYNAMICS**

Total Contact Hours		T	P	C
Theory	64	2	3	3
Practical	96			

AIMS: To transfer the knowledge of fundamentals of thermodynamics, laws and properties of gases, thermodynamic processes and cycles, formation and properties of steam, steam boilers and their performance , steam and Gas turbines , I.C. Engines, Air compressors and their performance, refrigeration and air conditioning etc.

Course Contents:

1. Fundamentals of Thermodynamics	08 Hrs
2. Laws and properties of perfect gases	06 Hrs
3. Thermodynamic processes and cycles	10 Hrs
4. Formation and properties of Steam	4 Hrs
5. Steam Boilers and their performance	8 Hrs
6. Steam and Gas turbines	8 Hrs
7. Internal Combustion Engines	8 Hrs
8. Air Compressors and their performance	6 Hrs
9. Refrigeration and Air Conditioning	6 Hrs
	<u>Total 64 Hrs</u>

Details of Contents:

1. Fundamentals of Thermodynamics	<u>8 Hrs</u>
1.1 Introduction to thermodynamics	
1.2 Units, Systems of units, Thermodynamic systems, its classification and properties	
1.3 Heat, Mass and weight, Force, Work and power	
1.4 Temperature, Absolute Temperature and Temperature Scales, Normal / Standard Temperature and Pressure	
1.5 Pressure, Absolute pressure, Gauge pressure and Vacuum pressure	
1.6 Energy, Potential energy, Kinetic energy and Internal energy of gas	
1.7 Laws of thermodynamics, Laws of conservation of energy and matter, limitations of 1 st law of thermodynamics	
1.8 Solution of problems by direct application of formulae for above topics	
1.9 Mode of heat transfer	
2. Laws and properties of perfect gases	<u>6 Hrs</u>
2.1 Introduction	
2.2 Boyle's law, Charles law, Gay-Lussac's law, Joule's law, Avogadro's law, Regnault's law and Dalton's law	
2.3 General gas equation, Characteristic Gas equation, Universal Gas equation	
2.4 Specific heats of a gas, Molar specific heats of a gas and its mathematical relations	

- 2.5 Enthalpy, and Entropy of a gas, importance of Entropy and relation between Heat & Entropy
- 2.6 Solution of problems by direct application of formulae for above topics
- 3. Thermodynamic processes and cycles 10 Hrs**
- 3.1 Introduction of thermodynamic process
- 3.2 Classification/types of thermodynamic processes
- 3.3 Application of 1st law of thermodynamics for work done during a non flow-reversible process
- 3.4 Heating and Expansion of gases in Non flow-Reversible & Irreversible processes
- 3.5 Solution of problems by direct-application of formulae
- 3.6 Introduction and classification/types of thermodynamic cycles
- 3.7 Assumptions in thermodynamic cycles
- 3.8 Reversible and Irreversible cycles
- 3.9 Working of an ideal engine
- 3.10 CARNOT's Cycle, OTTO Cycle, DIESEL Cycle and Dual Combustion Cycle
- 3.11 Solution of problems for air standard efficiency of thermodynamics cycles
- 4. Formation and properties of Steam 4 Hrs**
- 4.1 Introduction of steam, its formation, properties and classification
- 4.2 Important terms used for steam
- 4.3 Temperature-Enthalpy and Temperature- Entropy diagrams for steam formation
- 4.4 Use of steam tables
- 4.5 Calculation of total heat of Wet ,dry and super-heated steam (Solution of Problems)
- 5. Steam Boilers and Their performance 8 Hrs**
- 5.1 Introduction of boiler
- 5.2 Classification of boilers
- 5.3 Selection of a steam boiler
- 5.4 Important terms used for steam boilers
- 5.5 Constructions and Working of:
- 5.5.1 Simple vertical boiler (Single tube boiler)
- 5.5.2 COCHRAN boiler (Multi tubular boiler)
- 5.5.3 Locomotive Boiler
- 5.5.4 Marine boiler (scotch type)
- 5.5.5 Babcock and Wilcox Boiler
- 5.6 Boiler mountings and accessories
- 5.7 Comparison between Water Tube and Fire Tube boilers
- 5.8 Performance of steam boilers, Equivalent evaporation and boiler efficiency
- 5.9 Solution of problems regarding equivalent evaporation, power/H.P and efficiency of boiler
- 6. Steam and Gas Turbines 8 Hrs**
- 6.1 Introduction and classification of turbines
- 6.2 Steam Turbine (Impulse type)
- 6.2.1 Introduction
- 6.2.2 De-Laval impulse turbine
- 6.2.3 Advantages of steam turbine
- 6.3 Steam turbine (Reaction type)
- 6.3.1 Introduction.
- 6.3.2 PARSON's Reaction turbine.
- 6.3.3 Comparison between Impulse & Reaction Turbines
- 6.4 Gas Turbines
- 6.4.1 Introduction
- 6.4.2 Classification
- 6.4.3 Cycles of Gas turbines
- 6.4.4 Uses of Gas turbines

- 6.4.5 Comparison of closed cycle and open cycle turbines
- 6.4.6 Comparison of Gas turbine & Steam turbine

7. Internal Combustion Engines 8Hrs

- 7.1 Introduction of Internal & External Combustion Engines
- 7.2 Classification of I.C. Engines
- 7.3 Cycle of operations & important terms used
- 7.4 Comparison of Two Strokes Cycle and Four Strokes Cycle Engines
- 7.5 Petrol Engine
 - 7.5.1 Construction and working with the help of P-V , T-S diagrams & neat sketch
 - 7.5.2 Valve Timing Diagrams for two strokes and four strokes cycle petrol engine
- 7.6 Diesel Engine
 - 7.6.1 Construction and working with its P-V, T-S diagrams and neat sketch
 - 7.6.2 Valve Timing Diagrams for two strokes cycle and four strokes cycle Diesel engine
- 7.7 Indicated power, Brake power, Friction power and efficiencies of I.C. Engines
- 7.8 Comparison of I.C. engine and E.C. engine
- 7.9 Comparison of Petrol and Diesel engines
- 7.10 Solution of Problems regarding I.P, B.P, Friction Power and efficiencies of I.C. engines

8. Air Compressors and their performance (Reciprocating & Rotary) 6 Hrs

- 8.1 Introduction
- 8.2 Classification of air compressors(Reciprocating & Rotary)
- 8.3 Technical terms used
- 8.4 Construction and working of single stage reciprocating Air Compressor with help of PV-diagram and neat sketch
 - 8.4.1 Work done per cycle by a single stage reciprocating air compressor without and with clearance volume.
- 8.5 Multistage compression and its advantages
- 8.6 Two stage reciprocating air compressor with intercooler, work done per cycle with polytrophic law of compression
- 8.7 Power required to drive a single stage and two stage reciprocating air compressors
- 8.8 Comparison of reciprocating and rotary air compressors
- 8.9 Work done per cycle and power required to drive a rotary compressor
- 8.10 Solution of Problems regarding work done power required for single stage & multistage rotary air compressors

9. Refrigeration and Air Conditioning 6Hrs

- 9.1 Introduction
- 9.2 Classification of refrigeration systems / cycles
- 9.3 Units, terms used
- 9.4 Refrigerants and its properties
- 9.5 Introduction to vapor compression , vapour absorption in refrigeration system
- 9.6 Fundamentals of air conditioning system
- 9.7 Classification of air conditioning systems

Recommended Textbooks:

1. **Principle of Refrigeration by Royj. Dossat**
2. **Air conditioning principles and system an energy approach by Edward. G. Pita**
3. **Applied Thermodynamics T.D Eastop, A. Mcconkey**
4. **Thermodynamics by Rayner Joel**
5. **Thermodynamics Applied to Heat Engines by E.H.LEWITT (Published by; Sir ISAAC Pitman & Sons Ltd London)**
6. **Heat Engines by D.A Low (McGraw Hill Book Company , New York)**

Instructional Objectives:

At the completion of this course, the students will be able to:

1. Know the Fundamentals of Thermodynamics

- 1.1 State the following:
 - 1.1.1 Fundamentals of thermodynamics
 - 1.1.2 Units and Systems of units
- 1.2 Describe the Thermodynamic systems, its classification and properties
- 1.3 State the following:
 - 1.3.1 Heat
 - 1.3.2 Mass and weight
 - 1.3.3 Force
 - 1.3.4 Work and power
- 1.4 Describe the following:
 - 1.4.1 Temperature, Absolute Temperature and Temperature Scales
 - 1.4.2 Normal Temperature and Pressure
 - 1.4.3 Standard Temperature and Pressure
- 1.5 Describe the following:
 - 1.5.1 Pressure and Absolute pressure.
 - 1.5.2 Gauge pressure and Vacuum pressure
- 1.6 State the following:
 - 1.6.1 Energy, Potential energy and Kinetic energy
 - 1.6.2 Internal energy of a gas
- 1.7 Describe the following:
 - 1.7.1 Laws of thermodynamics
 - 1.7.2 Laws of conservation of energy and matter
 - 1.7.3 Limitations of 1st law of thermodynamics
- 1.8 Describe mode of heat transfer
 - 1.8.1 Describe Conduction**
 - 1.8.2 Describe Convection**
 - 1.8.3 Describe Radiation**
- 1.9 Solve the problems by direct application of formulae for the above topics

2. Understand the laws and properties of perfect gases

- 2.1 State the perfect gas and its properties
- 2.2 Describe the following; also derive its mathematical relations:
 - 2.2.1 Boyle's law
 - 2.2.2 Charles's law
 - 2.2.3 Gay-Lussac's law
 - 2.2.4 Joule's law
 - 2.2.5 Avogadro's law
 - 2.2.6 Regnault's law
 - 2.2.7 Dalton's law
- 2.3 Describe the following; also derive its mathematical relations:
 - 2.3.1 General gas equation
 - 2.3.2 Characteristic Gas equation
 - 2.3.3 Universal Gas equation
- 2.4 Describe the following:

- 2.4.1 The two specific heats of a gas and derive its mathematical relations
- 2.4.2 The molar specific heats of a gas and derive its mathematical relations
- 2.5 State the following:
 - 2.5.1 Enthalpy of a Gas
 - 2.5.2 Entropy of a gas
 - 2.5.3 Importance of Entropy
 - 2.5.4 Relation between Heat & Entropy
- 2.6 Solve the problems by direct application of formulae for the above topics

3. Understand the Thermodynamics Processes and Cycles

- 3.1 State the thermodynamic process
- 3.2 State Classification /Types of thermodynamic processes
- 3.3 State the application of 1st law of thermodynamics for work done during a non flow-reversible process
- 3.4 Describe the following
 - 3.4.1 The Non flow-Reversible & Irreversible processes with the help of P-V & T-S diagrams
 - 3.4.2 The constant pressure process with the help of P-V & T-S diagrams: also derive its mathematical relations for work done during expansion
 - 3.4.3 The constant volume process with the help of P-V & T-S diagrams: also derive its mathematical relations for work done during expansion
 - 3.4.4 The constant temperature process with the help of P-V & T-S diagrams: also derive its mathematical relations for work done during expansion
 - 3.4.5 The adiabatic process with the help of P-V & T-S diagrams: also derive its mathematical relations for work done during expansion
 - 3.4.6 The polytropic process with the help of P-V & T-S diagrams: also derive its mathematical relations for work done during expansion
- 3.5 Solve the problems by direct application of formulae for the above topics
- 3.6 Describe the following:
 - 3.6.1 Thermodynamic cycle with the help of P-V diagram
 - 3.6.2 Classification / Types of thermodynamic cycles
- 3.7 Describe the assumptions in thermodynamic cycles
- 3.8 Describe the Reversible & Irreversible cycles with help of PV diagram
- 3.9 Explain the construction and working of an ideal engine with the help of neat sketch
- 3.10 Explain the following
 - 3.10.1 CARNOT'S CYCLE with the help of P-V & T-S diagrams; also derive its mathematical relations for Air Standard Efficiency during the cycle of operation
 - 3.10.2 OTTO CYCLE with the help of P-V & T-S diagrams; also derive its mathematical relations for Air Standard Efficiency during the cycle of operation
 - 3.10.3 DIESEL CYCLE with the help of P-V & T-S diagrams; also derive its mathematical relations for Air Standard Efficiency during the cycle of operation
 - 3.10.4 DUAL COMBUSTION CYCLE with the help of P-V & T-S diagrams; also derive its mathematical relations for Air Standard Efficiency during the cycle of operation
- 3.11 Solve the problems by direct application of formulae for the above topics

4. Understand the Formation and properties of Steam

- 4.1 Describe the steam formation, its properties and classification
- 4.2 State the important terms used for steam
- 4.3 Describe the Temperature-Enthalpy and Temperature- Entropy diagrams for steam formation
- 4.4 Describe the use of steam tables with help of examples
- 4.5 Describe the following:
 - 4.5.1 Derive the formulae for the calculation of total heat of wet, Dry, and super heated steam
 - 4.5.2 Solve the problems by direct application of formulae for the above topics

Understand the Steam Boilers & its performance

- 5.1 Describe the working and general construction of a boiler
- 5.2 Describe the classification of boilers
- 5.3 State the selection factors of a good steam boiler
- 5.4 Describe the important terms used for steam boilers
- 5.5 Explain the Following:
 - 5.5.1 The construction and working of Simple Vertical Boiler with the help of neat sketch
 - 5.5.2 The construction and working of COCHRAN Boiler (Multi tubular boiler) with the help of neat sketch
 - 5.5.3 The construction and working of MARINE Boiler (Scotch type) with the help of neat sketch
 - 5.5.4 The construction and working of Locomotive Boiler with the help of neat sketch
 - 5.5.5 The construction and working of Babcock and Wilcox Boiler with the help of neat sketch
- 5.6 State the List of boiler mountings & accessories:
- 5.7 Make a Comparison between Water tube and Fire tube boilers
- 5.8 Describe the following with the help of mathematical expressions
 - 5.8.1 Performance of boiler
 - 5.8.2 Equivalent evaporation of boiler
 - 5.8.3 Efficiency of boiler
- 5.9 Describe the Following :
 - 5.9.1 The formulae for the calculation of power /H.P and efficiency of boiler
 - 5.9.2 Solve the problems by direct application of formulae for above topics

5. Understand the Steam and Gas Turbines

- 6.1 State the introduction and classification of turbines
- 6.2 Explain the following:
 - 6.2.1 The construction and working of De-Level Impulse turbine with the help of neat sketch
 - 6.2.2 State the advantages of steam turbine over reciprocating steam engine
- 6.3 Explain the following:
 - 6.3.1 The Construction and working of PARSON'S Reaction turbine with the helping neat sketch
 - 6.3.2 Make a comparison between Impulse and Reaction turbine
- 6.4 Describe the following
 - 6.4.1 The introduction of Gas Turbines
 - 6.4.2 The classification/types of Gas turbines
 - 6.4.3 The cycles of Gas turbine with help of diagram
 - 6.4.4 State the uses of gas turbines
 - 6.4.5 Make a Comparison of closed cycle and open cycle turbines
 - 6.4.6 Make a Comparison of Gas turbine and steam turbine

6. Understand the Internal Combustion Engines

- 7.1 State the introduction of I.C and E.C Engines(Internal and External combustion engines)
- 7.2 Describe the classification of I.C Engines
- 7.3 Describe the cycle of operations with the help of P-V diagram and important terms used for I.C Engines
- 7.4 Make a comparison of two strokes cycle and four strokes cycle engines
- 7.5 Explain the following:
 - 7.5.1 The Construction and working of PETROL Engine with the help of PV- diagram & neat sketch
 - 7.5.2 The valve timing diagrams for two strokes and four strokes cycle PETROL Engine

- 7.6 Explain the following:
 - 7.6.1 The Construction and working of DIESEL Engine with the help of PV- diagram & neat sketch
 - 7.6.2 The valve timing diagrams for two strokes and four strokes cycle DIESEL Engine
- 7.7 Describe the following also derive its mathematical formulae:
 - 7.7.1 Indicated power
 - 7.7.2 Brake power
 - 7.7.3 Friction power
 - 7.7.4 Efficiencies of I.C. engines
- 7.8 Make a Comparison of I.C. and E.C. engines
- 7.9 Make a Comparison of PETROL and DIESEL engines
- 7.10 Solve problems for calculation of I.P, B.P, Friction Power and efficiencies of I.C. engines

7. Understand the Air Compressors and their performance (Reciprocating & Rotary)

- 8.1 State the introduction of Air Compressors
- 8.2 Describe the classification / types of Air Compressors(Reciprocating & Rotary)
- 8.3 State the terms used for Air Compressors
- 8.4 Explain the following:
 - 8.4.1 The Construction and working single cylinder- single stage double acting reciprocating air compressor with the help of P-V diagram and neat sketch
 - 8.4.2 The work done single stage. Single cylinder reciprocating air compressor without and with clearance volume; also drive its Mathematical Expression.
- 8.5 Describe the Multistage compression with the help of P-V diagram and its advantages
- 8.6 Describe the two stage reciprocating air compressor with intercooler; also derive its mathematical Expression for the work done per cycle considering polytropic law of compression
- 8.7 Describe the power required to drive a single stage and two stages reciprocating Air compressors; also derive its formulae
- 8.8 Make a comparison of reciprocating and rotary air compressors
- 8.9 Describe the work done and power required to drive a rotary air compressor; also derive its formulae
- 8.10 Solution of the problems regarding work done and power required to drive the rotary and reciprocating air compressors

9. Understand the Refrigeration and Air Conditioning

- 9.1 State the concept of Refrigeration and Air conditioning
- 9.2 Describe the Classification/types of Refrigeration systems
- 9.3 State the Units and terms used for Refrigeration and Air Conditioning
- 9.4 State the names and Properties of refrigerants
- 9.5 Describe the simple mechanism of a vapor compression **vapour absorption** in refrigeration system with the help of neat schematic diagram
- 9.6 State the fundamentals of Air Conditioning Systems
- 9.7 Describe the Classification/types Air Conditioning Systems

List of Practical:

1. **Pressure measurement by Barometer**
2. **Introduction of Thermometers and Thermocouples**
3. **Sketch and study of Steam Boilers**
 - 3.1 Simple vertical boiler
 - 3.2 Cochran (Multi tubular) boiler
 - 3.3 Marine boiler(Scotch type)
 - 3.4 Locomotive boiler
4. **Sketch and study of Boiler Mountings and Accessories**
 - 4.1 Pressure gauge (Bourdon type)
 - 4.2 Water level indicator
 - 4.3 Safety valve (Spring loaded)
 - 4.4 Feed water pump
5. **Problem solving on steam generation**
6. **Practice on Petrol Engine**
7. **Practice on Diesel Engine**
8. **Practice on Ignition systems for I.C. Engines**
9. **Study and problem solution on Steam Turbine**
10. **Study of Gas Turbine**
11. **Performance Test of Reciprocating Air Compressor**
12. **Performance Test of Heating and Cooling system (Compression type A/C system)**
13. **Performance Test of Refrigeration system (Compression type)**

Practical Objectives:

96 Hrs

AIMS: To transfer practical knowledge of pressure, temperature measuring instruments, boilers, I.C. engines, Turbines and air compressors etc. The students will be able to:

- 1. Pressure measurement by Barometer**
 - 1.1 Construction and working of BAROMETER
 - 1.2 Calculation of pressure measurement
- 2. Know Thermometers and Thermocouples**
 - 2.1 Operate to learn the construction and working of Thermometers & Thermocouples
 - 2.2 Application the method of calibration
- 3. Sketch and study of the following boilers**
 - 3.1 **Study** the construction, working and safety precautions of:
 - 3.1.1 Simple Vertical Boiler
 - 3.1.2 Cochran (Multi tubular) Boiler
 - 3.1.3 Marine Boiler (Scotch types)
 - 3.1.4 Locomotive Boiler
 - 3.1.5 Babcock and Wilcox Boiler
- 4. Sketch and study of the following Boiler Mountings and Accessories**
 - 4.1 **Study** the construction, working and safety precautions of:
 - 4.1.1 Pressure Gauge (Bourdon type)
 - 4.1.2 Water level Indicator
 - 4.1.3 Safety Valve (Spring loaded)
 - 4.1.4 Feed Water Pump
- 5. Problem solving on Steam Boiler**
 - 5.1 **Study** the procedural steps for operations of a boiler
 - 5.2 **Study** the performance of a boiler & safety precautions
- 6. Practice on Petrol Engine**
 - 6.1 Operate to learn the construction, working and safety precautions
 - 6.2 Operate to learn the valves timing diagrams for 2- Stroke & 4 – Stroke cycle petrol engines
- 7. Practice on Diesel Engine**
 - 7.1 Operate to learn the construction, working and safety precautions
 - 7.2 Operation of the valves timing diagrams for 2- Stroke & 4 – Stroke cycle diesel engines
- 8. Practice on Ignition system for I.C. Engines**
 - 8.1 Operate to learn the ignition system for petrol engine
 - 8.2 Operate to learn the ignition system for diesel engine
- 9. Study and problem solution Turbine**
 - 9.1 **Study** the construction, working and safety precautions of steam turbines
 - 9.2 **Study** the performance of steam turbines
- 10. Performance test of Gas Turbine**
 - 10.1 Operate to learn the construction, working and safety precautions of Gas turbines
 - 10.2 Practical performance of Gas turbines
- 11. Practical test of Reciprocating Air Compressor**
 - 11.1 Operate to learn the construction, working and safety precautions of Reciprocating Air Compressor

11.2 Practical performance of Reciprocating Air Compressor

12. Performance Test of Heating and Cooling system (Compression type A/C system)

12.1 Operate to learn the general components of system

12.2 Operate to learn the operational procedure of system and safety measures

13 Performance Test of Refrigeration system (Compression type)

13.1 Operate to learn the general components of system

13.2 Operate to learn the operational procedure of system and safety measures

List of Machinery:

1.	Barometer	5-Set
2.	Dead Weight Gauge Tester with Pressure gauge	1
3.	Thermometers of Celsius, Fahrenheit, Kelvin and Rankine	5
4.	Thermocouples(Different Ranges)	2
5.	Sectioned model of Simple Vertical Boiler	2
6.	Sectioned model of COCHRAN (Multi tubular boiler)	2
7.	Sectioned model of Marine Boiler (Scotch types).	2
8.	Sectioned model of Locomotive Boiler	2
9.	Working model of safety valve (spring loaded)	5
10.	"C" class working boiler water tube/fire tube package type with all mounting and accessories	1
11.	Working model of steam Turbine (Impulse and Reaction type)	1+1
12.	Working model of gas turbine(Impulse and Reaction type)	1+1
13.	Reciprocating air compressor	1
14.	Rotary air compressor	1
15.	Ignition point Testing Machine	1
16.	Air Compressor Testing Machine	1
17.	Gas Turbine Testing Machine	1
18.	AC System Trainer (Heating and Cooling)	1
19.	Refrigeration Trainer	1
20.	Working models of Petrol Engine	1
21.	Working models of Diesel Engine	1

Mech-331

INDUSTRIAL PLANNING

AND PRODUCTION

Total contact Hrs:		T	P	C
Theory	32	1	0	1

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

- i) Understand the fundamental functions of industrial concerns.
- ii) Understand the methods(which methods, specify) generally employed in various manufacturing organizations

Course Contents:

1. Industrial planning	3 Hrs
2. Site selection for industry	2 Hrs
3. Plant lay out	4 Hrs
4. Production methods	3 Hrs
5. Job analysis	6 Hrs
6. Production planning and control	4 Hrs
7. Quality assurance	2 Hrs
8. Maintenance activities	4 Hrs
9. Cost determination and control	2 Hrs
10. Store operation in industry	2 Hrs

Detail of Contents:

1. Industrial Planning	3 Hrs
1.1 Need of industrial planning	
1.2 Phases of industrial planning	
2. Site selection for Industry	2 Hrs
2.1 Economical and technical factors considered while selecting factory site	
3. Plant layout	4 Hrs
3.1 Definition	
3.2 Objectives	
3.3 Types	
3.4 Criteria for a good lay out	
3.5 Advantages of a good lay out	
3.6 Preparing a lay out	
4. Production Methods	3Hrs
4.1 Introduction to production	
4.2 Important types of production	
5. Job Analysis	6Hrs
5.1 Motion study	
5.2 Time study	

6. Production planning and control	4Hrs
6.1 Production planning	
6.2 Production control	
7. Quality assurance	2Hrs
7.1 Inspection	
7.2 Quality control	
8. Maintenance activities	4Hrs
8.1 Responsibilities of maintenance department	
8.2 Types of maintenance	
8.3 Comparison of different types of maintenance	
8.4 Replacement studies	
9. Cost determination and control	2Hrs
9.1 Cost calculation of industrial product.	
9.2 Cost control	
10. Store operation in industry	2Hrs
10.1 Receipt of store items	
10.2 Records of store	
10.3 Issue of store items	

Recommended Textbooks:

- 1. Motion and time study by RALPH M. BARNES (Publisher: Wiley, 1980)**
- 2. Industrial Engineering and Management System by Dr. Mansor Ali (Publisher: Urban Resauce Center,2001)**
- 3. Factory and Production Management by Lockyer(Publisher: Pitman, 1974)**
- 4. Industrial Management by Prof. M.H. Zubairi**

Instructional Objectives:**1. Industrial planning**

- 1.1 Explain the need of industrial planning
 - 1.1.1 Define industrial planning
 - 1.1.2 Explain need and importance of industrial planning
- 1.2 Explain different phases of industrial planning
 - 1.2.1 Explain financial planning
 - 1.2.2 Explain product planning and selection of material
 - 1.2.3 Explain selection of process and equipment

2. Know the Economical and technical factors considered during site selection Procedure

- 2.1 Explain economical and technical factors in site selection
 - 2.1.1 Define site (location of industry)
 - 2.1.2 Describe factors for site selection
 - 2.1.3 Economical factors (cost of site, rebate in taxes, special grants)
 - 2.1.4 Technical factor(availability of labor, raw material, market of Product, services , transportation etc.)

3. Understand plant lay out

- 3.1 Define plant lay out and its importance
- 3.2 Describe the objectives of lay out
- 3.3 Describe the types of lay out (product/process) with its advantages and limitations
- 3.4 Explain criteria for a good lay out
- 3.5 Describe advantages of a good lay out
- 3.6 Explain different factors / procedures followed in preparing layout
 - 3.6.1 Explain factors considered while preparing a lay out (man. Material, machine, Movement etc.)
 - 3.6.2 Describe procedure and various steps followed in developing a lay out

4. Production Methods

- 4.1 Define Production.
- 4.2 Explain different types of production
 - 4.2.1 Explain Mass Production, Job order Production, Batch Production
 - 4.2.2 Explain flow Production
 - 4.2.3 Describe requirements of flow production

5. Job Analysis

- 5.1 Explain motion study
 - 5.1.1 Define motion study
 - 5.1.2 Explain techniques developed by the gilbreth, like therbligs, process charts etc.
 - 5.1.3 Describe micro motion study
- 5.2 Explain time study
 - 5.2.1 Define time study
 - 5.2.2 Describe uses of time study
 - 5.2.3 Describe instruments used in motion and time study
 - 5.2.4 Describe time study procedure
 - 5.2.5 Explain observation sheet (Time study tool)

6. Production Planning and Control (PPC)

- 6.1 Define PPC
- 6.2 Describe the objectives of PPC
- 6.3 Explain functions of production control
- 6.4 Explain routing, scheduling and loading

6.5 Explain Packaging and Dispatching

7. Quality Assurance

7.1 Explain inspection and its types

7.2 Explain quality control and assurance

7.2.1 Explain quality control and assurance at various levels

7.2.2 Describe quality standards

8. Maintenance Activities

8.1 Explain duties of maintenance department.

8.2 Explain types of maintenance

8.2.1 Explain Preventive maintenance and Break-down maintenance

8.2.2 Describe maintenance schedules

8.3 Explain replacement studies

8.3.1 Explain replacement of parts in machines and equipment

8.3.2 Explain replacement policy

9. Cost Determination and Control

9.1 Explain cost calculation of industrial products

9.1.1 Explain procedure of cost calculation

9.1.2 Describe elements of cost

9.1.3 Explain factory overhead

9.2 Describe cost control

10. Store Operation

10.1 Explain procedure adopted by the store on receipt of store items

10.2 Describe forms used in store operation

10.3 Explain the procedure of issuance of store items

Mech-343
MACHINE DESIGN

Total Contact Hours:

T P C

Theory: 64 Hrs

2 3 3

Practical: Machine design 96 Hrs

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

- i) Calculate and analyze stresses induced in different machine parts
- ii) Design Simple machine parts, welded joints, Screwed joints, pressure vessels, shafts and Couplings, Keys, Belt Drives, helical springs, Bearings and CAMS & Followers.

Course Contents:

1. Simple Stresses in Machine Parts	8Hrs
2. Pressure Vessels	6Hrs
3. Welded Joints	6Hrs
4. Screwed Joints	6Hrs
5. Design of Keys	5Hrs
6. Shafts and Couplings	8Hrs
7. Belt Drives	6 Hrs
8. Springs	6Hrs
9. Bearings	6 Hrs
10. Cam and Followers	7 Hrs

Details of Contents:

1. Simple Stresses in Machine Parts	8Hrs
1.1 Load and its types	
1.2 Stress and strain	
1.3 Tensile stress and strain	
1.4 Compressive stress and strain	
1.5 Shear stress and strain	
1.6 Young's Modulus of elasticity	
1.7 Modulus of rigidity or Shear Modulus	
1.8 Stress strain diagram	
1.9 Working stress	
1.10 Factor of safety	
1.11 Selection of Factor of Safety	
1.12 Poisson's Ratio	
1.13 Temperature stress	
1.14 Volumetric strain and bulk modulus	
1.15 Resilience and Toughness	
1.16 Solution of problems of the above topics by direct application of formulae	

- 2. Pressure Vessels** **6Hrs**
- 2.1 Introduction
 - 2.2 Classification of pressure vessels
 - 2.2.1 According to dimensions.
 - 2.2.2 According to end – construction
 - 2.3 Stresses in a thin cylindrical shell due to internal pressure
 - 2.3.1 Hoop stress
 - 2.3.2 Longitudinal stress
 - 2.4 Calculation of thickness of cylinder by direct application of formula, while all parameters are provided (e.g., Pressure. Internal Dia, hoop or longitudinal stress and efficiency of joint are given)
 - 2.5 Calculation of hoop or longitudinal stress by direct application of formula, while P. d, t and efficiency of joint are given
 - 2.6 Thin spherical shell subjected to internal pressure
 - 2.7 Calculation of thickness of spherical shell when all other parameters are provided by direct application of formula
 - 2.8 Thick cylindrical shell subjected to internal pressure
 - 2.9 Calculation of thickness of thick vessel made of brittle material by LAME,S equation, while all other parameters are given
- 3. Welded Joints** **6Hrs**
- 3.1 Types of various welding joints
 - 3.2 Strength of transverse and parallel fillet welded joint under static and fatigue loading
 - 3.3 Calculation of length of weld under static loading, when load, plate thickness & width, tensile & shears stress are given
- 4. Screwed Joints** **6Hrs**
- 4.1 Introduction
 - 4.2 Advantages and disadvantages
 - 4.3 Thread terminology
 - 4.4 Stress in screwed fastening due to external forces under static loading
 - 4.5 Initial stress due to screwing up forces
 - 4.6 Solution of simple problem by direct formula application
- 5. Design of Keys** **5 Hrs**
- 5.1 Introduction
 - 5.2 Types of keys
 - 5.3 Forces acting on a sunk key
 - 5.4 Strength of a sunk key
 - 5.5 Calculate length of sunk key by direct application of formula, while all parameters are directly provided
- 6. Shafts and Couplings** **8Hrs**
- 6.1 Introduction to shaft
 - 6.2 Materials used for shaft and its properties
 - 6.3 Types of shafts
 - 6.4 Standard sizes
 - 6.5 Stresses in shafts
 - 6.6 Shafts subjected to twisting moment
 - 6.6.1 Solid shaft
 - 6.6.2 Hallow shaft
 - 6.7 Calculate diameter of solid and hollow shafts by direct application of formula
 - 6.8 Shafts subjected to bending moment
 - 6.8.1 Solid shaft
 - 6.8.2 Hollow shaft
 - 6.9 Calculate diameter of solid and hollow shaft (bending only) by direct application of formula

- 6.10 Calculation of dia. of shaft subjected to bending and twisting moments
 - 6.11 Introduction of shaft coupling
 - 6.12 Types of couplings
 - 6.13 Design of flange coupling
 - 6.14 Solve problems on calculation of sizes of different components in flange coupling by direct application of formula
- 7. Belt Drives 6 Hrs**
- 7.1 Introduction to Belt and pulley drives
 - 7.2 Selection of Belt drive
 - 7.3 Types of Belt drive
 - 7.4 Type of Belts and pullies
 - 7.5 Type of Flat Belts drive
 - 7.6 Velocity ratio of Belt drive
 - 7.7 Slip / creep of Belt
 - 7.8 Length of open Belt drive
 - 7.9 Solve problem to find out the speed of shaft considering the diameters of flat pulleys and slip between belt and flat pulleys
- 8. Springs 6Hrs**
- 8.1 Introduction
 - 8.2 Types and uses of springs
 - 8.3 Materials used for helical springs
 - 8.4 Terms used in helical springs
 - 8.5 Stresses in helical springs of circular wire
 - 8.6 Deflection of helical springs of circular wire
 - 8.7 Solution of simple problem on helical springs of circular wire regarding finding out stresses, deflection and diameter of wire by direct application of formulae
- 9. Bearings 6 Hrs**
- 9.1 Functions of bearings
 - 9.2 Classification of bearing
 - 9.2.1 Depending upon the direction of load to be supported
 - 9.2.2 Depending upon the nature of contact
 - 9.3 Uses of bearings
 - 9.4 Terms used in journal bearings
 - 9.5 Lubrication of bearings
 - 9.6 Solution of simple problems on journal bearings when all parameter of journal bearing are directly provided
- 10. Cam and Follower Design 7Hrs**
- 10.1 Cam and its Types
 - 10.2 Followers and its Types
 - 10.3 Terminology of Cam and Follower
 - 10.4 Cam profile design

Instructional Objectives:**1. Simple Stresses in Machine Parts**

- 1.1 Describe Load and its types
 - 1.1.1 Dead load
 - 1.1.2 Live load
 - 1.1.3 Suddenly applied load
 - 1.1.4 Impact load
- 1.2 Describe Stress and strain
- 1.3 Describe Tensile stress and strain
- 1.4 Describe Compressive stress and strain
- 1.5 Describe Shear stress and strain
- 1.6 Describe Modulus of elasticity
- 1.7 Describe Modulus of rigidity
- 1.8 Explain Stress strain diagram
 - 1.8.1 Proportional limit
 - 1.8.2 Elastic limit
 - 1.8.3 Yield points
 - 1.8.4 Ultimate stress
 - 1.8.5 Breaking stress
 - 1.8.6 Percentage reduction in area
 - 1.8.7 Percentage elongation
- 1.9 Describe Working stress
- 1.10 Describe Factor of safety
- 1.11 Describe selection of factor of safety
- 1.12 Describe Poisson's ratio
- 1.13 Describe temperature stress
- 1.14 Describe volumetric strain and bulk modulus
- 1.15 Describe Resilience and Toughness
- 1.16 Solve of simple problems of the above topics by direct application of formula

2. Pressure Vessels

- 2.1 Describe pressure vessels
- 2.2 Explain Classification of pressure vessels
 - 2.2.1 According to dimensions
 - 2.2.2 According to end – construction
- 2.3 Explain Stresses in a thin cylindrical shell due to internal pressure
 - 2.3.1 Hoop stress
 - 2.3.2 Longitudinal stress
- 2.4 Calculate thickness of cylinder by direct application of formula, while all parameters are provided (e.g., Pressure. Internal Dia, hoop or longitudinal stress and efficiency of joint are given)
- 2.5 Calculate hoop or longitudinal stress by direct application of formula, while P. d, t and efficiency of joint are given
- 2.6 Explain thin spherical shell subjected to internal pressure
- 2.7 Calculate thickness of spherical shell when all other parameters are provided by direct application of formula
- 2.8 Explain Thick cylindrical shell subjected to internal pressure
- 2.9 Solve simple problem to Calculate of thickness of thick vessel made of brittle material by LAME,S equation, while all other parameters (e.g., Pressure. Internal Dia, tensile stress) are given

3. Welded Joints

- 3.1 Describe list of types of various welding joints
- 3.2 Explain strength of transverse and parallel fillet welded joint under static and fatigue loading
- 3.3 Calculation of length of weld under static loading and fatigue loading, when load, plate thickness, plate width, tensile and shears stress are given

4. Screwed Joints

- 4.1 Describe Screwed Joints
- 4.2 Describe Advantages and disadvantages of Screwed Joints
- 4.3 Explain Thread terminology
 - 4.3.1 Major diameter
 - 4.3.2 Minor diameter
 - 4.3.3 Pitch diameter
 - 4.3.4 Pitch
 - 4.3.5 Lead
 - 4.3.6 Helix and Helix angle
 - 4.3.7 Thread angle
 - 4.3.8 Root
 - 4.3.9 Crest and Apex
- 4.4 Explain Stresses in screwed fastening due to external forces under static loading
- 4.5 Describe Initial stress due to screwing up forces
- 4.6 Solve simple problem on screwed fastening by direct application of formula

5. Design of Keys

- 5.1 Describe Keys and its use
- 5.2 Describe Types of keys
 - 5.2.1 Sunk keys
 - 5.2.1.1 Rectangular (Parallel & Taper) Sunk key
 - 5.2.1.2 Square (Parallel & Taper) Sunk key
 - 5.2.1.3 Gib-Head key
 - 5.2.1.4 Feather key
 - 5.2.1.5 Wood ruff key
 - 5.2.2 Saddle keys
 - 5.2.2.1 Flat Saddle Key
 - 5.2.2.2 Hollow Saddle Key
 - 5.2.3 Tangent keys
 - 5.2.4 Round keys
 - 5.2.5 Splines
- 5.3 Describe Forces acting on a sunk key
- 5.4 Explain strength of a sunk key
- 5.5 Solve simple problem to Calculate length of sunk key (Square & Rectangular) by direct application of formula, while all parameters are directly provided

6. Shafts and Couplings

- 6.1 Describe Shafts
- 6.2 Describe Materials used for shaft and its properties
- 6.3 Describe Types of shafts
- 6.4 Describe Standard sizes of shafts
- 6.5 Describe Stresses in shafts
- 6.6 Explain shafts subjected to twisting moment
 - 6.6.1 Solid shaft
 - 6.6.2 Hallow shaft
- 6.7 Solve simple problem to Calculate diameter of solid and hollow shafts by direct application of formula

- 6.8 Explain shafts subjected to bending moment
 - 6.8.1 Solid shaft
 - 6.8.2 Hollow shaft
- 6.9 Solve simple problem to Calculate diameter of solid and hollow shaft (under bending only) by direct application of formula
- 6.10 Solve simple problem to calculate dia. of shaft subjected to combined bending and twisting moments
- 6.11 Describe Shafts coupling
- 6.12 Describe Types of couplings
- 6.13 Explain design of flange coupling
- 6.14 Solve problems on calculation of sizes of different components in flange coupling by direct application of formula

7. Belt Drives

- 7.1 Introduction to Belt and pulley drives
- 7.2 Describe Selection of Belt drive
- 7.3 Describe Types of Belt drive
 - 7.3.1 Light drives
 - 7.3.2 Medium drives
 - 7.3.3 Heavy drives
- 7.4 Describe Types of Belts and pullies
 - 7.4.1 Flat belt and pullies
 - 7.4.2 V-belt and pullies
 - 7.4.3 Circular belt and pullies
- 7.5 Describe Types of Flat Belts drive
 - 7.5.1 Open belt drive
 - 7.5.2 Crossed or Twist belt drive
 - 7.5.3 Quarter Turn belt drive
 - 7.5.4 Belt drive with idler pulley
 - 7.5.5 Compound belt drive
- 7.6 Explain Velocity ratio of Belt drive
- 7.7 Explain Slip of Belt
- 7.8 Describe Length of open Belt drive
- 7.9 Solve problem to find out the speed of shaft considering the diameters of flat pulleys and slip between belt and flat pulleys

8. Springs

- 8.1 Describe function of springs
- 8.2 Explain Types and uses of springs
 - 8.2.1 Helical spring
 - 8.2.2 Conical and volute spring
 - 8.2.3 Torsion spring
 - 8.2.4 Leaf spring
 - 8.2.5 Disc spring
- 8.3 Describe Materials used for springs
- 8.4 Explain Terms used in helical springs of circular wire along with formulae for each term
- 8.5 Derive formula for torsional and direct shear stress induced in helical springs of circular wire. Maximum shear stress should also be found out by considering the effect of wire curvature
- 8.6 Derive formula for deflection of spring
- 8.7 Solve problems on stresses, deflection and diameters for helical springs of circular wire by direct application of formulae

9. Bearings

- 9.1 Describe function of bearings
- 9.2 Explain classification of bearing
 - 9.2.1 Depending upon the direction of load to be supported
 - 9.2.1.1 Radial bearing
 - 9.2.1.2 Thrust bearing
 - 9.2.2 Depending upon nature of contact
 - 9.2.2.1 Friction bearing or sliding contact bearing
 - 9.2.2.2 Anti friction or rolling contact bearing
- 9.3 Describe uses of bearings
- 9.4 Describe terms used in hydrodynamic journal bearing
- 9.5 Explain lubrications of bearings
- 9.6 Solve simple problems on journal bearing when load on shaft, speed of shaft, viscosity of lubricant, bearing pressure, coefficient of friction and bearing modulus are provided.

10. Cam and Follower Design

- 10.1 Explain Cam and its Types
 - 10.1.1 Cylindrical Cam
 - 10.1.2 Radial Cam
 - 10.1.3 Wedge type Cam
 - 10.1.4 Face Cam
- 10.2 Describe Followers and its Types
 - 10.2.1 Roller Follower
 - 10.2.2 Knife Edge Follower
 - 10.2.3 Flat face Follower
 - 10.2.4 Spherical face Follower
- 10.3 Define Terminology of Cam and Follower
 - 10.3.1 Base circle
 - 10.3.2 Trace Point
 - 10.3.3 Pressure angle
 - 10.3.4 Pitch point
 - 10.3.5 Pitch circle
 - 10.3.6 Prime circle
 - 10.3.7 Lift or Stroke
 - 10.3.8 Dwell
- 10.4 Explain Cam profile design
 - 10.4.1 Draw/ Sketch displacement diagram, velocity and acceleration diagram when knife edge follower moves with uniform velocity
 - 10.4.2 Draw/ Sketch displacement diagram, velocity and acceleration diagram when knife edge follower moves with Simple Harmonic Motion(S.H.M)

Recommended Textbooks:

1. **Machine Design by: Paul H. Black (Published by McGraw Hill Book Company , New York)**
2. **Machine Design by Stanton. E. Wiston (Published by McGraw Hill Book Company , New York)**
3. **Machine Design by: Lafayette. Ind. (Purdue University of California)**

List of Practical:

1. **Calculate** (tensile, compressive and shear), stress and strain, modulus of elasticity, %age elongation, %age reduction in area, factor of safety for simple machine parts
2. **Calculate** force required to punch a hole
3. **Calculate** thickness and diameter of thin cylinders for hoop and longitudinal stresses
4. **Calculate** thickness of thick cylinders by LAME 'S Equation
5. **Calculate** thickness and diameter of spherical shell.
6. Design welded joints for transverse and parallel fillet weld under static loading only
7. **Calculate** stresses setup due to initial tightening and external load on screws .
8. Check dimensions of square and rectangular keys due to failure in shearing and crushing.
9. Design solid shaft subjected to twisting moment only.
10. Design hollow shaft subjected to twisting moment only.
11. Design Solid & Hollow shafts subjected to combined bending & twisting moment.
12. Design un-protected flange coupling for specific torque.
13. Check the speed of shaft when diameters of flat pulleys (Driver or Driven) and slip between belt and flat pulley is given .
14. Design the dimensions of closely coiled helical spring of circular wire subjected to tensile load.
15. Suggest suitable journal bearing, considering the load on shaft, speed ,viscosity of lubricant, bearing pressure, coefficient of friction and bearing modulus.
16. **Design and draw the CAM profile with knife edge follower for uniform velocity:**
(a) Out Stroke during 60° of Cam rotation (b) Dwell for next 30° of Cam rotation (c) return Stroke during next 60° of Cam rotation (d) Dwell of remaining 210° of Cam rotation (e) Stroke of follower is 22 mm (f) Minimum Radius of Cam is 50 mm (g) Axis of Follower is passing through axis of Cam shaft (h) Follower moves with uniform velocity during both out Stroke and return Stroke.

Practical objectives:

1. **Calculate (tensile, compressive and shear), strain, modulus of elasticity, %age elongation, %age reduction in area, factor of safety for simple machine parts**
 - 1.1 Stresses induced in machine parts
 - 1.2 Cross-sectional area of machine element under load
 - 1.3 modulus of elasticity of materials
 - 1.4 Calculate dimensions of component under specific load
 - 1.5 %age elongation and %age reduction in area of a component in a tensile test
2. **Calculate force required to punch a hole**
 - 2.1 Stresses induced in punch and plate
 - 2.2 Area of shear by the punch
 - 2.3 Calculate different cases of die and punch
3. **Calculate thickness and diameter of thin cylinders for hoop and longitudinal stresses**
 - 3.1 Difference between thin and thick shells
 - 3.2 Hoop and longitudinal stress in cylindrical shells
 - 3.3 Transverse and longitudinal failure of pressure vessel
4. **Calculate thickness of thick cylinders**
 - 4.1 Lame's equations for brittle materials
 - 4.2 Calculate Different cases of thickness of thick shells of brittle material
5. **Calculate thickness and diameter of spherical shell for circumferential stresses**
 - 5.1 Stresses on thin spherical shells
 - 5.2 Stress on spherical shells considering pressure, internal diameter, thickness and joint efficiency
6. **Design welded joints for transverse and parallel fillet under static loading only**
 - 6.1 Transverse and parallel fillet weld
 - 6.2 Observe tensile and shear stresses in transverse and parallel fillet weld
 - 6.3 Calculate different cases of transverse and parallel fillet weld under static and fatigue loading
7. **Analyze stresses setup due to initial tightening and external load on screws**
 - 7.1 Stress area of a screw
 - 7.2 Relation between core dia. and nominal dia. of a screw thread
 - 7.3 Initial tightening and its specific values
 - 7.4 Calculate different cases of external load raised by different bolts
8. **Check dimension of square and rectangular keys due to failure in shearing and crushing**
 - 8.1 Understand sunk keys of all types
 - 8.2 Understand sizes of keys proportional to the shaft diameter
 - 8.3 Check length of a sunk key for same material with shaft and equal strength with shaft
 - 8.4 Check torque transmitted by rectangular and square keys against shearing as well as crushing
 - 8.5 Calculate length of a sunk key when torque transmitted dia. of shaft, stress (shear & compressive) and width of key is given
9. **Design solid shaft subjected to twisting moment only**
 - 9.1 Understand twisting and bending moment on solid shaft
 - 9.2 Understand torsion and bending equation for strength of shaft
 - 9.3 Calculate diameters of shaft under torsion when torque to be transmitted and torsional shear stress is given

- 9.4 Analyze diameter of shafts subjected to combine bending and twisting moments
- 10. Design hollow shaft subjected to twisting moment only**
- 10.1 Understand twisting moment and bending moment on hollow shaft
- 10.2 Know torsion and bending equation
- 10.3 Calculate dia. of hollow shaft (inside & outside dia.) when bending moment, twisting moment and stresses are given
- 11. Design Solid & Hollow shafts subjected to combined bending & twisting moment**
- 11.1 Understand twisting moment and bending moment on solid & hollow shaft
- 11.2 Know torsion and bending equation
- 11.3 Calculate inside & outside dia. of hollow shaft when bending moment, twisting moment are given.
- 12. Design un-protected flange coupling for specific torque**
- 12.1 Un protected flange coupling
- 12.2 Know empirical size of flange coupling
- 12.3 Design assembly(hub, keys, flange, bolts) of unprotected type flange coupling.
- 13. Check the speed shafts(Driver or Driven) when diameters of flat pulleys and slip between belt and flat pulley is given**
- 13.1 Understand belt and belt drives
- 13.2 Calculate dimensions of flat pulleys for specific speed of shaft
- 13.3 Calculate the effect of slip between belt and pulley
- 14. Design the dimensions of closely coiled helical spring of circular wire subjected to tensile load.**
- 19.1 Understand helical springs of circular wire
- 19.2 Understand terms used in helical springs
- 19.3 Calculate deflection in helical spring
- 19.4 Solve problems on calculation of dimensions of helical springs
- 15. Suggest suitable journal bearing considering load on shaft, speed of shaft, viscosity of lubricant, bearing pressure, coefficient of friction and bearing modulus.**
- 15.1 Verify length of journal bearing
- 15.2 Know the viscosity of lubricants
- 15.3 Calculate the bearing modulus
- 15.4 Apply the coefficient of friction in the design of journal bearings
- 16. Design and draw the CAM profile with knife edge follower for uniform velocity**
- 16.1 Movement of knife edge follower
- 16.2 Practice to sketch Displacement, velocity and acceleration diagram when knife edge Follower.
- 16.3 moves with Simple Harmonic Motion (S.H.M)
- 16.4 Practice to sketch Displacement, velocity and acceleration diagram when knife edge follower moves with uniform velocity
- 16.5 Practice to draw CAM profile as given data

Mech-353
TOOL AND MOULD DESIGN

Mech-353**TOOL AND MOULD DESIGN**

Total Contact Hours		T	P	C
Theory	64 Hrs	2	3	3
Practical	96 Hrs			

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

- i) Know the importance of tool design and mould design
- ii) Principles of designing jigs and fixtures with their types
- iii) Design dies and punches, cutting tools
- iv) Describe Injection Moulding and Design of Moulds
- v) Describe the Die Casting Die Design

Course Contents:

1. Jigs and Fixture Design	10 Hrs
2. Form Tools	4 Hrs
3. Press and Press Work	6 Hrs
4. Punches and Dies Design	10Hrs
5. Sheet Metal Dies(Blanking, Piercing, Progressive, and Drawing Dies)	8Hrs
6. Die Casting	6 Hrs
7. Steel Standards used in Tool Making	4 Hrs
8. Injection Mould	4Hrs
9. Mould Design	12Hrs

Detail of Contents:

1. Jigs and Fixture Design	10Hrs
1.1 Introduction and importance of Production Tools	
1.2 Detail of Jigs and fixtures	
1.3 Material for jigs and fixtures	
1.4 Principles of location	
1.5 Design procedure	
1.6 Element of jigs and fixtures	
2. Form Tool	4 Hrs
2.1 Introduction of form tools	
2.2 Types of form tools	
2.3Design of form tools	
3. Press and Press Work	6 Hrs
3.1 Introduction to Press Working	
3.2 Fundamentals of Press working operations	
3.3 Types of presses	
3.4 Classification of presses	

3.5	General press information	
3.5.1	Press tonnage	
3.5.2	Stroke	
3.5.3	Shut height	
3.6	Material Handling equipment in press shop	
3.7	Different terms used in press working	
4.	Punches and dies Design	10 Hrs
4.1	Introduction of punches	
4.2	Types of punches with respect to operations	
4.3	Introduction of Dies	
4.4	Types of dies	
4.5	Punch and die design procedure	
4.6	Material used for punches and dies	
5.	Sheet metal Dies	8 Hrs
5.1	Design of Blanking , piercing , progressive and drawing dies	
5.2	Introduction of compound , inverted, Bending and Forming dies	
6.	Die Casting	6 Hrs
6.1	Introduction to Die Casting Machine	
6.2	Design of simple Die Casting Mould	
7.	Steel Standards used in Tool making	4 Hrs
7.1	Introduction to Steel Standards	
8.	Injection Mould	4 Hrs
8.1	Introduction of Injection Moulding Machine	
8.2	Mould and its Types	
8.3	Types of Plastic	
8.4	Process of injection moulding	
9.	Mould Design	12Hrs
9.1	Outline the design of injection mould	

Instructional Objectives:**1. Jigs and Fixture Design**

- 1.1 Understand production tool
 - 1.1.1 Define Jigs and fixture
 - 1.1.2 Explain jigs and fixtures
 - 1.1.3 Distinguish between jig and fixture
- 1.2 Understand different parts and types of jig and fixture
 - 1.2.1 Describe different types of standard parts i.e., nuts, bolts, screws, studs, washers of jig and fixture
 - 1.2.2 Explain the function of each part
 - 1.2.3 Enlist the types of jig and fixture
 - 1.2.3.1 Explain template plate type drill jig
 - 1.2.3.2 Explain plate type drill jig
 - 1.2.3.3 Explain Angle drill jig
 - 1.2.3.4 Explain swinging leaf drill jig
 - 1.2.3.5 Explain channel jig
 - 1.2.3.6 Explain Box and tumble jig
 - 1.2.3.7 Explain indexing jig
 - 1.2.3.8 Vise fixtures with series of special jaws
 - a) Simple pair of jaw for holding round work piece
 - b) Pair of jaw for holding thin sheet
 - c) Extended jaws for large work pieces
 - d) Tongue and groove jaws for accurate alignment
 - e) Wedge type jaws to hold the work piece against pressure
 - f) Link jaw to safe the work tilt upward
 - 1.2.3.9 Angle Milling fixture
 - 1.2.3.10 Turning fixture
 - 1.2.3.11 Broaching fixture
- 1.3 Understand different material used in jig and fixture
 - 1.3.1 Enlist different materials used in jig and fixture
 - 1.3.1.1 H.S.S., Die steel, Carbon steels, Nickel chrome Steel, High Tensile steel, Mild steel, Cast iron, Nylon , Fiber , Bronze ,etc.
 - 1.3.2 Describe the composition of material w .r .t. jig and fixture
- 1.4 Understand principle of location
 - 1.4.1 Explain 3.2.1 location
- 1.5 Understand design procedure
 - 1.5.1 Enlist the point to be consider while designing the jig and fixture
 - 1.5.2 (a)Rigidity (b) Location and clamping (d) Chip control (e) Jig feet and legs (f) safety in design.(g) Safety in designing (h) Weight of jig (i) Method of construction (j) Fool proofing
 - 1.5.3 Explain the point to be consider in detail
- 1.6 Understand tool guiding , tool supporting element tool clamping element, tool locating element
 - 1.6.1 Explain tool guiding elements
 - 1.6.1.1 Headed drill bush
 - 1.6.1.2 Headless drill bush
 - 1.6.1.3 Renewable drill bush

- 1.6.1.4 Master/liner bushes
- 1.6.2 Explain jig supporting elements
 - 1.6.2.1 Jig feet (a) square (b) hex type (c) adjustable type (d) round type
- 1.6.3 Explain tool standard clamping elements
 - 1.6.3.1 (a) Strap clamps (b) cam clamps (c) Screw clamps (d) latch clamps (e) Wedge clamps (f) Toggle clamps (g) Hydraulic and pneumatic clamps
- 1.6.4 Explain tool locating elements and locating methods
 - 1.6.4.1 (a) Pin and button locaters (b) lock pin screw locators (c) rest pads and plates (d) Chip control (f) Nest or Cavity location
 - 1.6.4.2 (a) Locating from plain surfaces (b) locating from circular surfaces (c) Locating from irregular surfaces

2. Form Tool

- 2.1 Introduction of Form tools
- 2.2 Types of Form Tools
 - 2.2.1 Flat form tool
 - 2.2.2 circular form tool
- 2.3 Flat form tool Design
- 2.4 Circular form tool Design

3. Press and Press Work Operations

- 3.1 Introduction to Press Working
- 3.2 Enlist and explain the Press working operations
 - 3.2.1 Punching / piercing
 - 3.2.2 Blanking
 - 3.2.3 Perforating
 - 3.2.4 Cutting off and parting
 - 3.2.5 Notching
 - 3.2.6 Lancing
 - 3.2.7 Drawing
 - 3.2.8 Bending
 - 3.2.9 Forming
 - 3.2.10 Embossing
 - 3.2.11 Coining
- 3.3 Describe different types of presses
 - 3.3.1 Hydraulic press
 - 3.3.2 Mechanical press
 - 3.3.2.1 CAM operated press
 - 3.3.2.2 Crank operated
 - 3.3.2.3 Eccentric operated
 - 3.3.2.4 Rack and pinion operated
 - 3.3.2.5 Toggle and knuckle joint press
 - 3.3.2.6 Screw press
 - 3.3.2.7 O.B.I press
 - 3.3.3 Explain CNC Presses
- 3.4 Classification of presses
 - 3.4.1 Classification w.r.t. type of frame
 - 3.4.2 Classification w.r.t source of power
 - 3.4.3 Classification w.r.t method of actuation of slides
 - 3.4.4 Classification w.r.t No. of slides incorporated
 - 3.4.5 Classification w.r.t intended use of special purpose
- 3.5 Describe general press information
 - 3.5.1 Press tonnage

- 3.5.2 Stroke
- 3.5.3 Shut height
- 3.5.4 Die space
- 3.6 Describe material handling equipments
 - 3.6.1 Coil unwinding equipment
 - 3.6.2 Strip straightening devices
 - 3.6.3 Strip feeding equipment
- 3.7 Describe different term used in press working
 - 3.7.1 Punch and Die
 - 3.7.2 Stroke
 - 3.7.3 Shut height
 - 3.7.4 Bolster plate
 - 3.7.5 Guide post pins and bushings
 - 3.7.6 Knock out pin
 - 3.7.7 Stripper
 - 3.7.8 Back up plate
 - 3.7.9 Upper and lower shoe

4. Punch and Die design

- 4.1 Understand punches
 - 4.1.1 Define punches
- 4.2 Describe the types of punches with respect to operations
 - 4.2.1 Explain Plain punches
 - 4.2.2 Explain Pedestal punches
 - 4.2.3 Explain Perforated punches
 - 4.2.4 Explain Compound punches
 - 4.2.5 Explain Pilot Punches
- 4.3 Understand dies
 - 4.3.1 Define die
- 4.4 Describe the types of dies.
 - 4.4.1 Explain simple blanking die and piercing die
 - 4.4.2 Explain Compound die
 - 4.4.3 Explain Progressive die
 - 4.4.4 Explain Drawing die
 - 4.4.5 Explain inverted die
- 4.5 Understand punch and die design procedure
 - 4.5.1 Clearance after considering the elastic recovery of the material
 - 4.5.2 Cutting force
 - 4.5.3 Method of reducing cutting force
 - 4.5.4 Punch and die mounting
- 4.6 Describe fundamental of die design (piercing and blanking)
 - 4.6.1 Blanking land piercing die construction
 - 4.6.2 Die block design
 - 4.6.3 Punch design and its types
 - 4.6.4 Pilot and its types
 - 4.6.5 Stripper and pressure pads
 - 4.6.6 Guide stops
 - 4.6.7 Stock strips
 - 4.6.8 Strips lay out

5. Sheet Metal Dies

- 5.1 Explain Sheet Metal Dies (Blanking, Piercing, Progressive and Drawing Dies)
- 5.2 Design of (Blanking, Piercing, Progressive and Drawing Dies)
- 5.3 Introduction of Compound, Inverted, Bending and Forming Die

6. Die Casting

- 6.1 Introduction to Die Casting Machine
 - 6.1.1 Explain die casting machine
- 6.2 Understand die casting Design
 - 6.2.1 Enlist the put line of die casting die design
 - 6.2.1.1 Gate location and size
 - 6.2.1.2 Vents
 - 6.2.1.3 Runner design
 - 6.2.1.4 Riser pin design
 - 6.2.1.5 Minimum section of thickness
 - 6.2.1.6 Design Core Type
 - 6.2.1.7 Draft requirements
 - 6.2.1.8 Core slide and pins
 - 6.2.1.9 Die materials

7. Standards of Steel used in Tool making

- 7.1 Introduction to Steel Standards
- 7.2 S.A.E, A.I.S.I, DIN, and BSS Standards

8. Injection Mould

- 8.1 Introduction of Injection Moulding Machine
- 8.2 State Mould and its Types
 - 8.2.1 Injection Moulding
 - 8.2.2 Compression Moulding
 - 8.2.3 Vacuum Moulding
 - 8.2.4 Extrusion Moulding
 - 8.2.5 Blow Moulding
- 8.3 State the Types of Plastic
 - 8.3.1 Thermosetting
 - 8.3.2 Thermo Plastic
- 8.4 Process of injection moulding
 - 8.4.1 State the stages of Injection Moulding
 - 8.4.1.1 Melting
 - 8.4.1.2 Injection
 - 8.4.1.3 Solidification
 - 8.4.1.4 Ejection

9. Mould Design

- 9.1 State the outline design of injection mould
 - 9.1.1 Basic mould structure
 - 9.1.2 Standard parts
 - 9.1.3 Gate and runner
 - 9.1.4 Ejection method
 - 9.1.5 Parting line
 - 9.1.6 Draft angle
 - 9.1.7 Mould shrinkage
 - 9.1.8 Air vent
 - 9.1.9 Mould cooling
 - 9.1.10 Strength and fastening Methods
 - 9.1.11 Cycle of injection Moulding
 - 9.1.12 Heating mechanism
 - 9.1.13 Introduction to DELCAM software in mould design

Recommended Textbooks:

- 1. Tool Design By Donaldson**
- 2. Machine Tool Technology by Repp / Mccarthy**
- 3. Mould Design by R.G.W. Pye**
- 4. Introduction to Jig and Tool Design by M.H.A Kempster**
- 5. Fundamental of Tool Design by: Frank W. Wilson (National Book Foundation Pakistan)**

List of Practical:

1. Draw standard parts used in jigs and fixtures i.e. hex. head nut & bolt, screws and washers 6 Hrs
2. Draw clamps,(a) hook type (b) latch type (c)quarter turn bolt (d)cam clamp 6Hrs
3. Draw locators 3Hrs
4. Draw template jig/plate type Jig 6 Hrs
5. Draw a swinging leaf jig 6Hrs
6. Draw an indexing jig 6Hrs
7. Draw an Angle milling fixture 3Hrs
8. Draw a lathe fixture for turning and boring operation 6 Hrs
9. Draw a blanking die and calculate the size of punch and die for making a blank of dia. 40 mm 6Hrs
10. Draw a progressive die and calculate the size of punch and die for making a washer inner dia.25 and outer dia 50mm 6 Hrs
11. Draw a simple drawing die for a cup for inner dia. 40mm, depth 30mm and sheet thickness 1mm 6 Hrs
12. Draw an injection moulding machine used in plastic injection moulding 3Hrs
13. Assembling / disassembling of simple mould 3 Hrs
14. Draw an injection mould of a Mobile Top by 3D CAD 30Hrs

Practical Objectives:

- 1. Draw standard parts used in jigs and fixtures(manual drawing) 6 Hrs**
 - 1.1 Draw hex head nuts, bolts, wing nut, knurling nut, as per standard production system
 - 1.2 Draw screws (counter sinking head screw, cap screw, machine screw, socket head screw)
 - 1.3 Draw different washers (plain, spring, and C-type washer)
- 2. Draw different types of clamps 6Hrs**
 - 2.1 Draw hook clamp, latch clamp cam clamp, eye bolt, strap clamps, plain wedge clamp
- 3. Draw locators 3 Hrs**
 - 3.1 Draw pin and button location
 - 3.2 Draw rest pad and plates
 - 3.3 Draw nest or cavity location
 - 3.4 Draw jig feet(rest button, hex rest button, jig leg, flat jig feet)
- 4. Draw template jig and plate type drill Jig 6Hrs**
 - 4.1 Draw the work piece to be drilled
 - 4.2 Draw the body of jig as per given job
 - 4.3 Draw the template and plate drill jig as per given job
- 5. Draw swinging leaf jig 6Hrs**
 - 5.1 Draw the work piece to be drill
 - 5.2 Draw the body of jig as per given work piece
 - 5.3 Draw clamps and locators for accurate location and easy clamping
 - 5.4 Draw proper drill bushings for guidance of twist drill
 - 5.5 Draw suitable jig feet(flat jig feet)
- 6. Draw an indexing jig 6 Hrs**
 - 6.1 Draw the work piece to be drilled
 - 6.2 Draw the body of work piece as per given w / p
 - 6.3 Draw locators and clamps for accurate location and clamping
 - 6.4 Draw drill bushing for guidance of twist drill
 - 6.5 Draw indexing mechanism
- 7. Draw an angle milling fixture 3Hrs**
 - 7.1 Draw the part to be milled
 - 7.2 Draw the main parts, the base, clamps, rest blocks or nest, locating points, and gauging surfaces
 - 7.3 Draw the assembled single piece milling fixture
- 8. Draw lathe fixture for turning and boring operation 6 Hrs**
 - 8.1 Draw the work piece to be turned or bored
 - 8.2 Draw the turning fixture
 - 8.3 Draw holding mechanism of fixture on lathe spindle
- 9. Draw simple blanking die for making a blank of dia 40mm 6Hrs**
 - 9.1 Draw the blank position in the strip
 - 9.2 Calculate the size of punch and die considering the elastic recovery of material
 - 9.3 Draw the piercing die and punch
 - 9.4 Draw the different types punches to reduce the cutting forces
- 10. Draw a progressive die for making a washer of inner dia.20, and outer 40mm. 6Hrs**
 - 10.1 Draw the piercing and blanking position in the strip inner dia 20 and outer dia 40mm

- 10.2 Draw the die block and calculate the size of punch and die after considering the elastic recovery of Material
- 10.3 Draw the pilot punch used in progressive die
- 11. Draw a simple drawing die for a cup for inner dia. 40mm, depth 30mm and sheet thickness 1mm 6Hrs**
- 11.1 Draw the work piece to be draw
- 11.2 Draw the single action draw die with spring loaded knockout
- 11.3 Calculate the percent reduction and depth of draws
- 11.4 Calculate blank size for a cup of 40mm inner dia., 30mm depth and sheet thickness 1mm
- 11.5 Calculate the drawing forces
- 12. Draw injection moulding machine. (Manual drawing) 3Hrs**
- 12.1 Draw the part to be moulded
- 12.2 Draw the injection moulding machine
- 13. Assembling/disassembling simple mould (manual drawing) 3Hrs**
- 13.1 Draw the simple mould for moulding a tray
- 14. Design an injection mould of a Mobile Top.ipt by 3D CAD 30Hrs**
- 14.1 Work piece (create the core and cavity)
- 14.2 Generating the core and cavity
- 14.3 Specifying the gate location
- 14.4 Sketching the runner system
- 14.5 Creating a runner
- 14.6 Creating a gate
- 14.7 Creating the mould base
- 14.8 Insert the ejector pins
- 14.9 Creating the sprue bushing
- 14.10 Creating the cooling channel
- 14.11 Adding cooling component
- 14.12 Documenting the mould assembly

List of Machinery:

- | | | |
|----|---------------------------------------|--------|
| 1. | 3D CAD Software (Mould Design) | 50-set |
| 2. | Computers | 50 |
| 3. | Drawing instruments and drawing sheet | 50 |

Mech-362
MATERIALS TESTING AND HEAT
TREATMENT

Total Contact Hours		T	P	C
Theory	32	1	3	2
Practical	96			

AIMS: After going through this course, student will be able to:

- I) Understand destructive and non-destructive test
- II) Understand working of testing equipment
- III) Know the basic theories of heat treatment processes
- IV) Understand common heat treatment processes
- V) Understand common heat treatment processes of non ferrous metals

Course Contents:

(A) MATERIALS TESTING

- 1. Mechanical properties of Metallic Materials** **2 Hrs**
- 2. Destructive Test** **7Hrs**
- 3. Non-Destructive Tests** **7Hrs**

(B) HEAT TREATMENT

- 4. Heat Treatment of steels** **3 Hrs**
- 5. Heat Treatment Processes** **4 Hrs**
- 6. Heat Treatment Equipment** **3 Hrs**
- 7. Case hardening Processes** **3 Hrs**
- 8. Heat Treatment of Non-Ferrous Metals and Cast iron** **3 Hrs**

Detail of Contents:

(A) MATERIALS TESTING

- 1. Mechanical properties of Metallic Materials** **2 Hrs**
 - 1.1 Mechanical Properties of Materials
 - 1.1.1 Hardness
 - 1.1.2 Toughness
 - 1.1.3 Ductility
 - 1.1.4 Malleability
 - 1.1.5 Elasticity
 - 1.1.6 Brittleness
 - 1.1.7 Plasticity
 - 1.1.8 Stiffness
 - 1.2 Testing of materials
 - 1.2.1 Destructive tests.
 - 1.2.2 Non destructive tests
- 2. Destructive Test** **7 Hrs**

- 2.1 Hardness tests
 - 2.1.1 Brinell hardness test
 - 2.1.2 Rockwell hardness test
 - 2.1.3 Vickers hardness test
- 2.2 Izod impact test
- 2.3 Tensile test
- 2.4 Compression Test
- 2.5 Bending test
- 2.6 Shear Test
- 2.7 Torsion test
- 2.8 Fatigue test

3. Non-Destructive Test 7 Hrs

- 3.1 Pressure Test
- 3.2 Hammer Test (Sonic Inspection)
- 3.3 Visual Inspection
- 3.4 Dye Penetrant Test
- 3.5 Eddy Current inspection
- 3.6 Ultrasonic Inspection
- 3.7 Magnetic Particle Inspection
- 3.8 Radiographic Inspection

B) HEAT TREATMENT

4. Heat Treatment of steels 3 Hrs

- 4.1 Iron-Iron_carbide diagram
- 4.2 Phase diagrams
- 4.3 Effect of heating on steel
- 4.4 Effect of cooling on steel

5. Heat Treatment Processes 4 Hrs

- 5.1 Annealing
- 5.2 Hardening
- 5.3 Tempering
- 5.4 Normalizing

6. Heat Treatment Equipment 3 Hrs

- 6.1 Heat Treatment Furnaces
- 6.2 Pyrometers
- 6.3 Metallurgical microscope

7. Case Hardening Processes 3 Hrs

- 7.1 Carburizing (pack, gas, liquid)
- 7.2 Induction hardening
- 7.3 Flame hardening
- 7.4 Cyaniding
- 7.5 Nitriding

8. Heat Treatment of Non-Ferrous Metals and Cast Iron 3 Hrs

- 8.1 Heat treatment of cast iron
- 8.2 Heat treatment of Non-ferrous metals and alloys
- 8.3 Annealing of non-ferrous metals and precipitation hardening

Recommended Textbooks:

1. **The Testing and Inspection of Engineering Materials** By Harmer E-Davis, George Earl Troxel (McGraw Hill Book Company, New York)
2. **Materials and Processes** by James. F. Young (Jhon wiley & sons Inc. New York)
3. **Physical Metallurgy** by AVNER

Instructional Objectives:**1. Mechanical properties of materials**

- 1.1 Know Mechanical Properties of Materials
 - 1.1.1 Enlist mechanical properties of materials (hardness, toughness, ductility, malleability, brittleness, elasticity, plasticity and stiffness)
 - 1.1.2 Define each property
- 1.2 Know Destructive Tests
 - 1.2.1 Enlist destructive tests
 - 1.2.2 Define each test
- 1.3 Know Non-Destructive Tests
 - 1.3.1 Enlist non-destructive tests
 - 1.3.2 Define each test

2. Destructive Tests

- 2.1 Understand Hardness Tests and selection of test for a material
 - 2.1.1 Explain Brinell Hardness Test
 - 2.1.1.1 Knows types of hardness tests
 - 2.1.1.2 Enlist parts of brinell hardness testing machine
 - 2.1.1.3 Explain working of brinell hardness testing machines
 - 2.1.1.4 Explain preparation of specimen for brinell hardness testing machine
 - 2.1.1.5 Explain the measurement of impression by microscope for brinell test
 - 2.1.1.6 Describe relevant calculations
 - 2.1.2. Explain Rockwell hardness testing machine
 - 2.1.2.1 Explain construction and working of Rockwell hardness testing machine (minor load, major load, scales B, C)
 - 2.1.2.2 Explain preparation of specimen for Rockwell hardness testing machine
 - 2.1.2.3 Appreciate correct dial reading procedure
 - 2.1.2.4 Enlist difference between brinell and Rockwell hardness testing
 - 2.1.3 Explain Vicker hardness test
 - 2.1.3.1 Describe Vicker hardness testing machine
 - 2.1.3.2 Explain Vicker hardness testing method
- 2.2 Explain the working Principles of Impact testing Machine
 - 2.2.1 Enlist capacity and parts of Izod impact machine
 - 2.2.2 Explain function of each part
 - 2.2.3 Explain working principle
 - 2.2.4 Explain preparation of specimen (ASTM, JIS, ISO)
 - 2.2.5 Appreciate correct dial reading technique
- 2.3 Explain the working Principle of Universal Testing Machine
 - 2.3.1 Describe tensile testing machine
 - 2.3.2 Enlist capacity and different parts of tensile testing machine and extensometer
 - 2.3.3 Describe different function of tensile testing machine
 - 2.3.4 Explain the preparation of standard tensile test specimen (ASTM, ISO)
 - 2.3.5 Explain the procedure of tensile test of mild steel
 - 2.3.6 Describe the stress strain curve obtained in a tensile test of mild steel

- 2.3.7 Describe the %age elongation and %age reduction in area of specimen in tensile test
- 2.3.8 State need of correct holding of specimen on machine
- 2.4 Explain Compression test
 - 2.4.1 Describe compression test
 - 2.4.2 Describe procedure for the conduct of compression test
 - 2.4.3 Describe standard specimen for compression test
- 2.5 Understand Bending Test
 - 2.5.1 Describe bending
 - 2.5.2 Explain bending test and shape factor
 - 2.5.3 Describe deflection in specimen and bending equation.
- 2.6 Understand Shear Test
 - 2.6.1 Explain shear test procedure on universal testing machine
 - 2.6.2 Explain shear stress calculation of round bar and punched plate specimen
- 2.7 Understand Torsion Testing Machines and Torsion Test
 - 2.7.1 Describe torsion
 - 2.7.2 Explain shafts subjected to twisting moment
 - 2.7.3 Explain working of torsion testing machine
 - 2.7.4 Explain procedure of torsion test
- 2.8 Understand Fatigue Testing Machine and Fatigue Test
 - 2.8.1 Define fatigue
 - 2.8.2 Describe the Phenomenon of Stress Hysteresis
 - 2.8.3 Describe cyclic loading
 - 2.8.4 Explain effect of fatigue on metals and fatigue failure
 - 2.8.5 Explain working of fatigue testing machine
 - 2.8.6 Explain procedure for fatigue test

3. Non Destructive Test

- 3.1 Describe Pressure Test(pneumatic, hydraulic)
- 3.2 Describe Hammer Test
- 3.3 Describe Visual Inspection
- 3.4 Explain Dye Penetrant Test
 - 3.4.1 Describe need and uses of Dye penetrant test
 - 3.4.2 Describe procedure of Dye penetrant test
- 3.5 Explain Eddy Current Inspection
 - 3.5.1. Describe need and uses of Eddy Current test
 - 3.5.2 Describe procedure of Eddy Current test
 - 3.5.3 Describe equipment of Eddy Current test
- 3.6 Understand Ultrasonic Test of metals
 - 3.6.1 Describe need and uses of Ultrasonic test In the Inspection of Metals and Metallic Component
 - 3.6.2 Explain Ultrasonic testing Equipment
 - 3.6.3 Describe procedure of Ultrasonic test
- 3.7 Understand Magnetic particles inspection Methods
 - 3.7.1 Enlist advantages disadvantages
 - 3.7.2 Explain the equipment used
 - 3.7.3 Explain the basic principle
 - 3.7.4 Explain crack detection procedure
- 3.8 Understand Radiographic inspection
 - 3.8.1 X-Ray Method
 - 3.8.1.1 Enlist advantages and disadvantages of x-ray test.
 - 3.8.1.2 Explain the basic principle of x-ray test
 - 3.8.1.3 Explain the equipment used
 - 3.8.1.4 Enlist the safety measures adapted in x-ray method

- 3.8.1.5 Explain the use of x-ray method in the inspection of castings and welded joints
- 3.8.2 Gamma Ray Method
 - 3.8.2.1 Describe basic principle of Gamma Rays methods
 - 3.8.2.1 Enlist advantages and disadvantages of Gamma Rays methods with respect to X-ray method

4. Heat Treatment

- 4.1 Understand Heat Treatment of Steel
 - 4.1.1 Describe heat treatment of steel
 - 4.1.2 Explain constituents of steel
 - 4.1.3 Describe allotropic phases of steel
 - 4.1.4 Explain change of structure on heating
 - 4.1.5 Explain role of heating rate/cooling rate
 - 4.1.6 Distinguish between micro and macro structure
 - 4.1.7 Sketch iron carbide diagram
 - 4.1.8 Describe significance of various areas in iron carbide diagram
 - 4.1.9 Explain role of iron carbide diagram in heat treatment of carbon steel
 - 4.1.10 Describe time temperature transformation diagram
- 4.2 Understand Phase Diagram(Alloy steel)
 - 4.2.1 Define phase diagram
 - 4.2.2 Explain importance of phase diagram
 - 4.2.3 Name different phases
 - 4.2.4 Explain different phases
- 4.3 Understand effect of heating on steels
 - 4.3.1 Describe heating curve of steels
 - 4.3.2 Describe its importance in heat treatment of steel
- 4.4 Understand Effect of rate of Cooling on Steel
 - 4.4.1 Explain the change of micro structure on cooling
 - 4.4.2 Explain the importance of rate of cooling
 - 4.4.3 Enlist different methods of cooling and its effect
 - 4.4.4 Explain cooling curve of steels

5. Heat Treatment Processes

- 5.1 Understand Hardening
 - 5.1.1 Describe hardening and its objectives
 - 5.1.2 Enlist steps taken in hardening
 - 5.1.3 Describe effects of cooling rate on hardening
 - 5.1.4 Define different media used for quenching
 - 5.1.5 Describe harden ability of steels
- 5.2 Understand Tempering
 - 5.2.1 Describe tempering and its objectives
 - 5.2.2 Describe austempering and martempering
- 5.3 Understand Annealing
 - 5.3.1 Define annealing and its objectives
 - 5.3.2 Describe types of annealing
 - 5.3.2.1 Process Annealing
 - 5.3.2.2 Full annealing
 - 5.3.2.3 Isothermal annealing
 - 5.3.2.4 Spherodizing annealing
- 5.4 Understand Normalizing
 - 5.4.1 Define Normalizing and its objectives
 - 5.4.2 Describe comparison between annealing and normalizing

6. Heat Treatment Equipment

- 6.1 Understand Heat Treatment Furnaces
 - 6.1.1 Describe heat treatment furnaces
 - 6.1.2 Classification of furnaces
 - 6.1.2.1 Hearth Furnaces(Muffle and Semi-Muffle)
 - 6.1.2.2 Bath furnaces
- 6.2 Understand Pyrometer
 - 6.2.1 Define Pyrometer
 - 6.2.2 Enlist types of pyrometers
 - 6.2.3 Enlist different parts of thermocouple optical pyrometer, radiation pyrometer
 - 6.2.4 Explain working principle of pyrometer
- 6.3 Understand Metallurgical Microscope
 - 6.3.1 Describe microscope
 - 6.3.2 Describe working and construction of metallurgical microscope
 - 6.3.3 Explain Metallography
 - 6.3.4 Describe preparation of specimen for metallography
 - 6.3.5 Describe etching and etchants
 - 6.3.6 Describe microstructure study of iron

7. Case Hardening Processes

- 7.1 Understand Carburizing
 - 7.1.1 Describe pack Carburizing
 - 7.1.2 Describe liquid Carburizing
 - 7.1.3 Describe gas Carburizing
- 7.2 Understand Induction hardening
 - 7.2.1 Induction hardening process
 - 7.2.2 Advantages of Induction hardening
- 7.3 Describe flame hardening
- 7.4 Describe cyaniding
- 7.5 Describe Nitriding

8. Understand Heat Treatment of Non Ferrous Metals, Alloys and Cast Iron

- 8.1 Explain heat treatment of cast iron
- 8.2 Explain heat treatment of non ferrous metals and alloys
- 8.3 Describe precipitation hardening and annealing of non ferrous metals

List of Practical:**(A) MATERIALS TESTING**

- | | |
|--|-------|
| 1. Practice for brinnell hardness test | 3 Hrs |
| 2. Practice for Rockwell hardness test for B-scale hardness | 6 Hrs |
| 3. Practice for Rockwell hardness test for C-scale hardness | 3 Hrs |
| 4. Practice for Izod test on cast iron or Aluminum standard test specimens | 3Hrs |
| 5. Practice for tensile test on universal testing machine on standard specimen | 6Hrs |
| 6. Practice for Compression test on cast iron specimen. | 6Hrs |
| 7. Practice for bending test on universal testing machine | 3 Hrs |
| 8. Practice for shear test on universal testing machine | 3 Hrs |
| 9. Practice for torsion test on torsion testing machine | 3 Hrs |
| 10. Practice for fatigue test | 3 Hrs |
| 11. Practice for Dye Penetrant test | 3 Hrs |
| 12. Practice for Ultrasonic test on ultrasonic testing equipment | 3 Hrs |
| 13. Practice for Magnetic particle test | 3Hrs |

(B) HEAT TREATMENT

- | | |
|--|-------|
| 14. Practice for working of metallurgical microscope | 3 Hrs |
| 15. Practice of preparation of specimen for metallography | 6 Hrs |
| 16. Observe grain size of micro-structure of mild steel specimen | 6 Hrs |
| 17. Observe micro-structure of cast iron specimen | 6 Hrs |
| 18. Practice for hardening and observe micro structure of carbon steel | 6Hrs |
| 19. Practice for annealing and observe grain structure of carbon steel | 6 Hrs |
| 20. Practice for normalizing and observe grain structure | 6 Hrs |
| 21. Practice for pack carburizing and observe grain structure | 6 Hrs |
| 22. Practice for stress relieving of Aluminum | 3 Hrs |

Practical Objectives:**(A) MATERIALS TESTING****1. Practice for Brinell hardness test**

After performing Brinell hardness test, the students should be able to:

- I) Perform grinding & polishing of specimen for Brinell test
- II) Perform Brinell test on Brinell testing machine
- III) Check hardness of metallic specimen

2. Practice for Rockwell hardness test for B-scale hardness

After performing Rockwell hardness test for B scale, the students should be able to:

- I) Perform grinding & polishing of specimen for Rockwell test
- II) Fit steel ball indenter into plunger & placing weights
- III) Perform Rockwell test for B scale with ball indenter

3. Practice for Rockwell hardness test for C-scale hardness

After performing Rockwell hardness test for C scale, the students should be able to:

- I) Perform grinding & polishing of specimen for Rockwell test
- II) Fit Diamond Cone indenter into plunger & placing weights
- III) Perform Rockwell test for C scale with Diamond Cone indenter

4. Practice for Izod test on cast iron and aluminum standard test specimens

After performing Izod test on Izod testing machine, the students should be able to:

- I) Make specimen of different materials according to specifications
- II) Set different energies or pendulum heights, according to the material, on the machine
- III) Perform Izod test on Izod testing machine
- IV) Able to determine the toughness of the material

5. Practice for tensile test on universal testing machine on standard specimen

After performing tensile test on Universal testing machine, the students should be able to:

- I) Make specimen according to standard size
- II) Mark gauge length points on the specimen
- III) Clamp specimen properly in the machine gripping jaws
- IV) Operate inlet and outlet oil valves of machine
- V) Draw stress strain curve on tracing unit of the machine
- VI) Remove broken specimen from machine jaws
- VII) Calculate all observations (% elongation, % reduction in area, yield stresses, ultimate tensile stresses, and breaking stresses) relevant to test

6. Practice for Compression test on cast iron specimen.

After performing Compression test on Universal testing machine, the students should be able to:

- I) Install compression attachment on machine
- II) Perform compression test on specimen
- III) Draw stress strain curve on tracing unit of the machine
- IV) Calculate compressive stress and all other observations relevant to test

7. Practice for bending test on universal testing machine

After performing bending test on Universal testing machine, the students should be able to:

- I) Fit bending fixture on Universal testing machine
- II) Perform bending test on specimen
- III) Calculate Modulus of elasticity and all other observations relevant to test

8. Practice for shear test on universal testing machine

After performing Shear test on Universal testing machine, the students should be able to:

- I) Install shear test fixture or die and punch on the machine

- II) Perform shear test on specimen
- III) Calculate ultimate shear stress of test specimen

9. Practice for torsion test on torsion testing machine

After performing Torsion test on Torsion testing machine, the students should be able to:

- I) Fit specimen on torsion testing machine
- II) Performing torsion test on specimen
- III) Calculate all observations relevant to test

10. Practice for fatigue test on fatigue testing machine

After performing Fatigue test on Fatigue testing machine, the students should be able to:

- I) Fit specimen on fatigue testing machine
- II) Perform fatigue test on specimen
- III) Calculate all observations relevant to test

11. Practice for Dye Penetrant test

After performing Dye penetrant test, the students should be able to:

- I) Clean and prepare surface for the test
- II) Apply fluorescent dye on the specimen
- III) Apply developer after cleaning the surface
- IV) Detect surface flaws, cracks, pin holes, surface discontinuities

12. Practice for Ultrasonic test on ultrasonic testing equipment

After performing Ultrasonic test ultrasonic on testing equipment, the students should be able to:

- I) Clean and prepare surface for the test
- II) Operate ultrasonic on testing equipment
- III) Detect flaws, blow holes and other internal defects in metals

13. Practice for Magnetic particle test on Magnetic particle testing equipment

After performing Magnetic particle test on Magnetic particle testing equipment, the students should be able to:

- I) Clean and prepare surface for the test
- II) Operate Magnetic particle testing equipment
- III) Detect flaws, blow holes and other internal defects in metals

(B) HEAT TREATMENT

14. Practice for working of metallurgical microscope

After practice of working of metallurgical microscope, the students should be able to:

- I) Know different parts of metallurgical microscope
- II) Operate metallurgical microscope
- III) Know function of each part
- IV) Draw a neat sketch of microscope indicating its different parts

15. Practice of preparation of specimen for metallography

After preparation of specimen for metallography the students should be able to:

- I) Grind and polish the specimen .Etching the specimen with etching solution
- II) Press specimen with plastic material

16. Observe grain size of micro-structure of mild steel specimen

After study of grain size of specimen the students should be able to

- I) Examine different microstructures of steel (ferrite, cementite, pearlite, etc.)

17. Observe grain size of micro-structure of cast iron specimen

After study of grain size of specimen the students should be able to:

- I) Examine different microstructures of cast iron (cementite, pearlite.. etc)

18. Practice for hardening and observe of micro structure of carbon steel

After hardening & quenching of specimen the students should be able to:

- I) Heat the carbon steel in heat treatment furnace
- II) Use proper quenching media
- III) Polish, grind, etch specimen for metallography
- IV) Examine microstructure of hardened steel

19. Practice for annealing and observe micro structure of steel

After annealing of specimen the students should be able to:

- I) Heat the steel or specimen on required temperature in electric furnace
- II) Give the steel soaking time
- III) Remove the specimen from furnace after slow cooling
- IV) Polish, grind, etch specimen for observe grain structure

20. Practice for normalizing of steel and observe grain structure

After Normalizing of specimen, the students should be able to:

- I) Heat the carbon steel specimen on required temperature in electric furnace
- II) Give the steel soaking time
- III) Remove the specimen from furnace after specified time
- IV) Keep the specimen in air for cooling
- V) Polish, grind, etch specimen and observe of grain structure

21. Practice for pack carburizing of steel and observe micro structure

After Pack-carburizing process of low carbon steel, the students should be able to:

- I) Pack and seal specimen with Carbonaceous materials in steel box
- II) Heat the specimen up to required time and temperature
- III) Check hardness difference between case and core
- IV) Polish, grind and etch specimen and observe grain structure

22. Practice for stress relieving of Aluminum

- I. Select and prepare specimen
- II. Heat up specimen in muffle furnace
- III. Cool the specimen at specific rate of cooling
- IV. Examine the specimen for its variation in strength

List of Machinery:

1.	Brinell Hardness Testing Machine	1
2.	Rockwell Hardness Testing Machine	1
3.	Izod Impact Testing Machine	1
4.	Universal Testing Machine	1
5.	Heat treatment Furnace (Electric)	1
6.	Specimen Cutoff Machine	1
7.	Specimen Polishing Machine	2
8.	Specimen Mount Press	1
9.	Pedestal Grinder	2
10.	Metallurgical Microscope (1000x)	3
11.	Torsion Testing machine	1
12.	Fatigue testing machine	1
13.	Quenching Bath	1
14.	Ultrasonic testing equipment	1
15.	Magnetic particle testing equipment	1

Mech-374

WORK SHOP PRACTICE – III

Mech-374**WORK SHOP PRACTICE – III**

Total Contact Hours	T	P	C
Theory 64	2	6	4
Practical 192			

AIMS At the end of this course the students will be able to:

- i) Operate Milling, Hobbing and Grinding machines
- ii) Make simple Mechanical projects
- iii) Write Project report

Course Contents:

1. Milling Machines	4 Hrs
2. Attachments and Work Holding Devices	4 Hrs
3. Milling Cutters	4Hrs
4. Milling Operations	2 Hrs
5. Gear Terminology and Spur Gear Calculation	4 Hrs
6. Indexing Methods	4 Hrs
7. Helical Milling	6 Hrs
8. Hobbing Machine	4 Hrs
9. Precision Grinding Machines	6Hrs
10. Grinding Operations	2 Hrs
11. Non-Traditional Machining Processes	4 Hrs
12. Project	20 Hrs

Detail Contents :

1. Milling Machines	4 Hrs
1.1 Types and constructions	
1.2 Parts and their function	
1.3 Care and Maintenance	
1.4 Safety precaution to operate milling machine	
2. Attachments and Work Holding Devices	4 Hrs
2.1 Milling attachments and accessories	
2.2 Work holding devices	
2.3 Compound angle setting	
3. Milling Cutters	4Hrs

3.1	Horizontal arbor milling cutters	
3.2	Vertical arbor milling cutters	
3.2	Cutter materials	
3.4	Cutting speed and feed for milling work	
4.	Milling Operations	2Hrs
4.1	Climb milling	
4.2	Conventional milling	
4.3	Plain milling	
4.4	Side milling	
4.5	End milling	
4.6	Slot milling	
4.7	Straddle milling	
4.8	Gang Milling	
4.9	Sawing	
4.10	Gear cutting	
5.	Gear Terminology and Spur Gear Calculation	4 Hrs
5.1	Gear and gear blank	
5.2	Spur gear terminology	
5.3	Spur gear formulae and calculations	
6.	Indexing Methods	4 Hrs
6.1	Introduction	
6.2	Direct indexing method and calculations	
6.3	Simple or plain indexing method and calculations	
6.4	Differential indexing method and calculations	
6.5	Angular indexing method and calculations	
7.	Helical Milling	6 Hrs
7.1	Use of helical gears in power transmission	
7.2	Lead of helical gear	
7.3	Lead of milling machines	
7.4	Formulae and calculation of helical gears	
7.5	Work table setting for left and right hand helical gears	
8.	Hobbing Machine	4 Hrs
8.1	Introduction	
8.2	Working principles of differential type hobbing machine	
8.3	Construction and use of hobbing machine	
8.4	Spur gear calculation and machine setting	
8.5	Helical gear calculation and machine setting	
9.	Precision Grinding Machines	6 Hrs
9.1	Types and construction	
9.2	Work holding devices and accessories	
9.3	Grinding fluids	
10.	Grinding Operations	2 Hrs
10.1	Surface grinding	
10.2	Cylindrical Grinding	
10.3	Internal grinding	
10.4	Form grinding	
10.5	Centerless grinding	
10.6	Form cutter grinding	
11.	Non-Traditional Machining Processes	4 Hrs

- 11.1 Electro-Discharge machining (EDM)and its working principle
- 11.2 Electron beam machining. (EBM)and its working principle
- 11.3 Electrolytic grinding (ELG)and its working principle
- 11.4 Electrochemical machining (ECM)and its working principle
- 11.5 Electrochemical Gridding (ECG)and its working principle
- 11.6 Ultrasonic Machining. (USM)and its working principle
- 11.7 Hydro-jet Machining / Water-jet machining (WJM)and its working principle
- 11.8 Laser beam machining (LBM)and its working principle

12. Project

20 Hrs

- 12.1 Introduction
- 12.2 Necessity and need of project
- 12.3 Planning a project
- 12.4 Detail and assembly drawings
- 12.5 Material requirements of project
- 12.6 Project report
- 12.7 Proposed projects
 - 12.7.1 Surface gauge
 - 12.7.2 Rack and Gear assembly
 - 12.7.3 Index plate of dividing head
 - 12.7.4 Spur gear assembly (simple gear train)
 - 12.7.5 Spur gear assembly (compound gear train)
 - 12.7.6 Helical gear assembly (Simple gear train)
 - 12.7.7 Helical gear assembly (Compound gear train)
 - 12.7.8 Lathe tool post (Square type)
 - 12.7.9 Shaper tool post
 - 12.7.10 Drill press vice
 - 12.7.11 Job supporting screw jack
 - 12.7.12 Working model of drilling machine
 - 12.7.13 Working model of shaper
 - 12.7.14 Any Other Project

Recommended Textbooks:

1. **Technology of machine tools by S.F.Krar and A.F.Check(Publisher: Mc GRAW-HILL , 2004)**
2. **Machine tool practice by RICHARD R. KIBBLE (Publisher: John Wiley & Sons, 2009)**
3. **Machine tool operation part II by Henry D.Burghardt**
4. **Workshop Technology part III by W.A.J Chapman**

Instructional Objectives:

- 1. Milling Machines**
 - 1.1 State working principle of milling machine
 - 1.2 Identify and describe the use of different types of milling machines
 - 1.3 Explain the construction of universal milling
 - 1.4 State safety precautions to operate milling machine
- 2. Attachments and Work Holding Devices**
 - 2.1 Describe the use and necessity of dividing head
 - 2.2 Describe the use and necessity of vertical head
 - 2.3 Describe the use and necessity of slotting head
 - 2.4 Describe the use and necessity of rotary table and slotting head
 - 2.5 Describe the use and necessity of machine vice and swivel base vice
 - 2.6 Describe the use and necessity of universal vice and milling arbor
- 3. Milling Cutters**
 - 3.1 Describe the use of horizontal arbor milling cutters
 - 3.2 Describe the use of vertical arbor milling cutters
 - 3.3 Describe the necessity and importance of different cutter materials
 - 3.4 Describe cutting speed and feeds as applied to milling work
 - 3.5 Calculate r.p.m. of milling spindle and feed rate in mm/mint
- 4. Milling Operations**
 - 4.1 Explain climb and conventional milling
 - 4.2 Explain plain and side milling
 - 4.3 Explain end milling and slotting
 - 4.4 Explain straddle and gang milling
 - 4.5 Explain sawing and gear cutting
- 5. Gear Terminology and Spur Gear Calculation**
 - 5.1 Describe difference between gear and gear blank
 - 5.2 Explain gear terminology in detail
 - 5.3 Calculate module, gear blank size, depth of cut, circular pitch etc
- 6. Indexing Methods**
 - 6.1 Define indexing
 - 6.2 Explain direct indexing method in detail
 - 6.3 Explain simple/plain indexing method in detail
 - 6.4 Explain differential indexing method in detail
 - 6.5 Explain angular indexing method in detail
 - 6.6 Calculate all above said indexing methods
- 7. Helical Milling**
 - 7.1 Describe difference between spur and helical gear
 - 7.2 Describe the use of helical gears in power transmission
 - 7.3 Explain the lead of helical gear
 - 7.4 Explain the lead of milling machine
 - 7.5 Describe the work table setting for right/left hand helical gears
 - 7.6 Explain the formulae and calculation for helical gears
- 8. Hobbing Machine**
 - 8.1 Describe the working principle of hobbing machine
 - 8.2 Describe the construction and use of vertical differential type hobbing machine
 - 8.3 Explain spur gear formulae , calculation and machine setting

8.4 Explain helical gear formulae , calculation and machine setting

9. Precision Grinding Machines

- 9.1 Describe the construction and use of surface grinding machine
- 9.2 Describe the construction and use of cylindrical grinding machine
- 9.3 Describe the construction and use of universal grinding machine
- 9.4 Describe the construction and use of universal tool and cutter grinding machine
- 9.5 Describe the importance and use of grinding fluids
- 9.6 Described the work holding devices for all above said Machine and accessories

10. Grinding Operations

- 10.1 Describe surface and cylindrical grinding
- 10.2 Describe internal and form grinding
- 10.3 Describe centre less and form cutter grinding

11. Non-Traditional Machining Processes

- 11.1 Describe Electro Discharge Machining (EDM) and its working principle
- 11.2 Describe Electron Beam Machining (EBM) and its working principle
- 11.3 Describe Electrolytic Grinding (ELG) and its working principle
- 11.4 Describe Electro Chemical Machining (ECM) and its working principle
- 11.5 Describe Ultrasonic Machining (UM) and its working principle
- 11.6 Describe Hydro-Jet Machining / Water Jet Machining (WJM) and its working principle
- 11.7 Describe Laser Beam Machining (LBM) and its working principle

12. Project

- 12.1 Describe the necessity and need of the project
- 12.2 Explain material requirements of the project
- 12.3 Describe the importance of detail and assembly drawings
- 12.4 Explain the importance of right process selection
- 12.5 Estimation and costing of the project
- 12.6 Explain the format of project report
- 12.7 Explain project report writing including drawings, procedures, material list, process chart, cost and difficulties faced and suggestions for improvements

List of Practical:

1. Practice of Slot milling	9Hrs
2. Practice of Spur rack cutting	9Hrs
3. Practice of Helical rack cutting	9Hrs
4. Practice of Spur gear cutting (Direct indexing method)	9 Hrs
5. Practice of Spur gear cutting (Plain indexing method)	9 Hrs
6. Practice of Spur gear cutting (Differential indexing method)	9 Hrs
7. Practice of Left hand helical gear cutting on milling machine	9 Hrs
8. Practice of Right hand helical gear cutting on milling machine	9 Hrs
9. Practice of Spur gear cutting on hobbing machine	9Hrs
10. Practice of Left hand helical gear cutting on hobbing machine	9Hrs
11. Practice of Right hand helical gear cutting on hobbing machine	9Hrs
12. Practice of Straight Bevel gear cutting on milling machine	9 Hrs
13. Practice of Grinding of flat surfaces	9 Hrs
14. Practice of Cylindrical Grinding operation	9 Hrs
15. Practice of Grinding of form milling cutter	9 Hrs
16. Practice of Straddle milling	9 Hrs
17. Project	48 Hrs

Practical Objectives:

- 1. Practice of Slot Milling**
 - 1.1 Check the alignment of machine vice
 - 1.2 Hold and check the level of the job accurately
 - 1.3 lay out the job properly
 - 1.4 Mill square or rectangular slots
- 2. Practice of Spur Rack Cutting**
 - 2.1 Check the alignment of machine vice parallel to the center line of milling machine spindle
 - 2.2 Set proper depth of cut
 - 2.3 Check horizontal level of the job
 - 2.4 Control pitch of rack properly
 - 2.5 Cut spur rack properly
- 3. Practice of Helical Rack Cutting**
 - 3.1 Set swivel base vice at required angle
 - 3.2 Hold and check level of the job
 - 3.3 Control linear pitch of rack properly
 - 3.4 Cut helical rack accurately
- 4. Practice of Spur Gear Cutting (Direct Indexing Method)**
 - 4.1 Mount proper index plate on the spindle of dividing head
 - 4.2 Locate the center of gear blank
 - 4.3 Set depth of cut accurately
 - 4.4 Index the job properly
 - 4.5 Cut spur gear accurately
- 5. Practice of Spur Gear Cutting (Plain Indexing Method)**
 - 5.1 Mount proper index plate on the dividing head
 - 5.2 Set dividing head for proper indexing
 - 5.3 Locate center of gear blank
 - 5.4 Set depth of cut accurately
 - 5.5 Cut spur gear accurately
- 6. Practice of Spur Gear Cutting (Differential Indexing Method)**
 - 6.1 Mount proper index plate on the dividing head
 - 6.2 Set dividing head for proper indexing and mount DR & DN gears on spindle and worm shaft
 - 6.3 Locate center of gear blank
 - 6.4 Check true running of the job
 - 6.5 Set depth of cut accurately
 - 6.6 Cut spur gear accurately
- 7. Practice of Left Hand Helical Gear Cutting on Milling Machine**
 - 7.1 Set suitable lead gears on milling machine
 - 7.2 Set work table at proper angle
 - 7.3 Set dividing head for proper indexing
 - 7.4 Locate center of gear blank
 - 7.5 Set depth of cut accurately
 - 7.6 Cut left hand helical gear properly
- 8. Practice of Right Hand Helical Gear Cutting on Milling Machine**
 - 8.1 Set suitable lead gears on milling machine
 - 8.2 Set work table at proper angle

- 8.3 Set dividing head for indexing
 - 8.4 Locate center of gear blank
 - 8.5 Set depth of cut accurately
 - 8.6 Cut right hand helical gear properly
- 9. Practice of Spur Gear Cutting on Hobbing Machine**
- 9.1 Mount index gears
 - 9.2 Mount speed and feed gears
 - 9.3 Hold and check true running of gear blank
 - 9.4 Set proper depth of cut
 - 9.5 Cut spur gear on hobbing machine accurately
- 10. Practice of Left Hand Helical Gear Cutting on Hobbing Machine**
- 10.1 Mount index gears
 - 10.2 Mount speed and feed gears
 - 10.3 Hold and check true running of gear blank
 - 10.4 Hold hob slide at proper angle
 - 10.5 Hold and check true running of gear blank
 - 10.6 Cut left hand helical gear on hobbing machine accurately
- 11. Practice of Right Hand Helical Gear Cutting on Hobbing Machine**
- 11.1 Mount index gears
 - 11.2 Mount speed and feed gears
 - 11.3 Hold and check true running of gear blank
 - 11.4 Hold hob slide at proper angle
 - 11.5 Hold and check true running of gear blank
 - 11.6 Cut right hand helical gear on hobbing machine accurately
- 12. Practice of Straight Bevel gear Cutting**
- 12.1 Hold job in the spindle of index head
 - 12.2 Set the index head for indexing and proper angle
 - 12.3 Check the true running of job
 - 12.4 Locate center of gear blank
 - 12.5 Adjust depth of cut
 - 12.6 Cut strait bevel gear
- 13. Practice of Grinding of Flat Surfaces**
- 13.1 Hold job on magnetic chuck properly
 - 13.2 Dress grinding wheel
 - 13.3 Take trial cut and set down feed
 - 13.4 Grind flat surfaces accurately
- 14. Practice of Cylindrical Grinding**
- 14.1 Hold the job between centers
 - 14.2 Dress grinding wheel
 - 14.3 Start work head
 - 14.4 Take trial cut and set feed collar at zero
 - 14.5 Grind cylindrical job accurately
 - 14.6 Check the diameter of the job
- 15. Practice of Grinding Form Milling Cutters**
- 15.1 Hold the cutter on mandrel and between centers
 - 15.2 Dress grinding wheel
 - 15.3 Set tooth rest properly
 - 15.4 Set wheel head for proper clearance
 - 15.5 Grind tooth of form milling cutter

16. Practice of Straddle Milling

- 16.1 Mount two sides and face cutters on arbor at proper distance
- 16.2 Hold and check the level of job
- 16.3 Layout the job properly
- 16.4 Locate the cutters on the job accordingly
- 16.5 Perform straddle milling operation

List of Machinery and Equipment:

1.	Lathe machine with all standard accessories(Size: 180mm x 900mm)	4-set
2.	Universal milling machine with all standard accessories	10
3.	Vertical milling machine with all standard accessories	2
4.	Drilling machine with all standard accessories	2
5.	Pedestal tool grinder	2
6.	Shaper with all standard accessories	1
7.	Power hacksaw with all standard accessories	1
8.	Cylindrical grinding machine with all standard accessories	1
9.	Surface grinding machine with all standard accessories	1
10.	Universal tool & cutter grinding machine with all standard accessories	1
11.	Vertical differential type hobbing machine with all standard accessories	1
12.	Arbor press	1

Mech-382

CAD / CAM

Mech-382**CAD / CAM**

Total Contact Hours		T	P	C
Theory	32	1	3	2
Practical	96			

AIMS: At the end of this course the students will be able to:

- I. Solid Modeling
- II. CAM for Milling
- III. CAM for Turning
- IV. CAM for Wire Cut(EDM)
- V. CAM for EDM(Die Sinker)

Course Contents:

1. Introduction to 2D and 3D CAD	2 Hrs
2. 2D Sketch	2 Hrs
3. Dimension and Constraint	2 Hrs
4. 3D Sketch	1 Hrs
5. Solid Modeling	8 Hrs
6. Assembly Modeling	4Hrs
7. Drawing View	1 Hr
8. Presentation Module	1 Hr
9. Sheet Metal Components	3 Hrs
10. CAM	8Hrs

Detail of Contents:

1. Introduction to 2D and 3D CAD	2 Hrs
1.1 Modules	
1.2 Toolbars	
1.3 Units and Dimensions	
1.4 Important Terms and Definitions	
2. 2D Sketch	2 Hrs
2.1 Sketch Environment	
2.2 Drawing Display Tools	
2.3 Sketching Entities	
2.4 Pattern	
2.5 Tolerance	
2.6 Work Feature	
3. Dimension and Constraint	2Hrs
3.1 Dimension	
3.2 Geometric Constraint	
3.2.1 Perpendicular Constraint	

3.2.2	Parallel Constraint	
3.2.3	Tangent Constraint	
3.2.4	Coincident Constraint	
3.2.5	Concentric Constraint	
3.2.6	Collinear Constraint	
3.2.7	Horizontal Constraint	
3.2.8	Vertical Constraint	
3.2.9	Equal Constraint	
3.2.10	Fix Constraint	
3.2.11	Symmetric Constraint	
3.2.12	Smooth Constraint	
3.3	Measurement	
4.	3D Sketch	1Hr
4.1	Parameter	
4.2	3D Sketching Entities	
5.	Solid Modeling	8Hrs
5.1	Modeling Tools	
5.1.1	Extrude Feature	
5.1.2	Revolve Feature	
5.1.3	Holes Feature	
5.1.4	Fillets Feature	
5.1.5	Chamfers Feature	
5.1.6	Ribs Feature	
5.1.7	Thicken and Offset Feature	
5.2	Concept of Edit Feature	
5.3	Advanced Modeling Tools	
5.3.1	Sweep Feature	
5.3.2	Lofted Feature	
5.3.3	Coil Feature	
5.3.4	Thread Feature	
5.3.5	Shell Feature	
5.3.6	Face Draft Feature	
5.3.7	Replacing Face Feature	
5.3.8	Boundary Patch Feature	
5.3.9	Stitching Surfaces Feature	
5.3.10	Sculpt Feature	
6.	Assembly Modeling	4Hrs
6.1	Types of Assembly	
6.2	Assembly Component	
6.2.1	Mate Constraint	
6.2.2	Angle Constraint	
6.2.3	Tangent Constraint	
6.2.4	Insert Constraint	
6.2.5	Rotation Constraint	
6.2.6	Rotation-Translation Constraint	
6.2.7	Transitional Constraint	
6.3	Edit Assembly Constraint	
7.	Drawing View	1Hr
7.1	Types of Views	
7.2	Drawing Standards	
7.3	Drawing Sheets	
7.4	Dimension Style	

7.5	Parts Lists	
8.	Presentation Module	1Hr
8.1	Presentation View	
8.2	Assembly Animation	
9.	Sheet Metal Components	3Hrs
9.1	Sheet Metal Components Parameter	
9.2	Sheets Metal Components	
9.2.1	Fold Feature	
9.2.2	Flange Feature	
9.2.3	Cut Feature	
9.2.4	Corner Seam Feature	
9.2.5	Bend Feature	
9.2.6	Corner Round Feature	
9.2.7	Corner Chamfer Feature	
9.2.8	Hem Feature	
9.2.9	Contour Flange Feature	
10.	CAM	8Hrs
10.1	Introduction of CAM	
10.1.1	User Interface	
10.1.2	Setup of materials	
10.1.3	Setup of cutting tools	
10.1.4	Strategy and cutting processes	
10.1.5	Generating tool paths	
10.1.6	Tool parts simulation	
10.2	2D CAM	
10.2.1	Holes Drilling	
10.2.2	Face cutting	
10.2.3	Side cutting	
10.2.4	Pocket cutting	
10.2.5	Slot cutting	
10.3	CAM Milling	
10.3.1	Rough cutting	
10.3.1.1	Z level Roughing	
10.3.1.2	Parallel Roughing	
10.3.1.3	Plunge Roughing	
10.3.1.4	Flat Roughing	
10.3.1.5	Cutting Boundaries	
10.3.1.6	Step over and leads	
10.3.2	Finish cutting	
10.3.2.1	Parallel Finishing	
10.3.2.2	Z Level Finishing	
10.3.2.3	Corner and Pencil Finishing	
10.3.2.4	Iso line Finishing	
10.3.2.5	Radial and Spiral Finishing	
10.3.2.6	Flow line Finishing	
10.3.2.7	Between 2 curves Finishing	
10.3.2.8	Swarf Finishing	
10.3.2.9	Cutting Finishing	
10.3.2.10	Step over Finishing	
10.4	CAM Lathe	
10.4.1	Facing	
10.4.2	Boring	

- 10.4.3 Grooving
- 10.4.4 Threading (Inside and Outside)
- 10.4.5 Cut off
- 10.5 CAM Wire Cut
 - 10.5.1 Die Cutting
 - 10.5.2 Punch Cutting
 - 10.5.3 Taper Cutting
 - 10.5.4 4 Axis Wiring Cutting
 - 10.5.5 No Core Cutting
- 10.6 CAM Router
 - 10.6.1 Contouring
 - 10.6.2 Pocketing
 - 10.6.3 Engraving
 - 10.6.4 Chamfering
 - 10.6.5 Raster to vector Translator
 - 10.6.6 Nesting
- 10.7 CAM Multi-Axis
 - 10.7.1 4 Axis Milling
 - 10.7.2 5 Axis Swarf Milling
 - 10.7.3 5 Axis Index Drilling

Recommended Textbooks:

1. **The CNC Work Shop by Frank Nanfara (Publisher: SDC Publications, 2002)**

Instructional Objectives:**1. Introduction of 3D CAD**

- 1.1 Describe Modules
- 1.2 Describe Toolbars
- 1.3 Describe Units and Dimensions
- 1.4 Describe Important Terms and Definitions

2. 2D Sketch

- 3.1 Explain Sketch Environment
- 3.2 Explain Drawing Display Tools
- 3.3 Explain Sketching Entities
- 3.4 Explain Pattern
- 3.5 Explain Tolerance
- 3.6 Explain Work Feature

3. Dimension and Constraint

- 3.1 Explain Dimension
- 3.2 Geometric Constraint
 - 3.2.1 Understand Perpendicular Constraint
 - 3.2.2 Understand Parallel Constraint
 - 3.2.3 Understand Tangent Constraint
 - 3.2.4 Understand Coincident Constraint
 - 3.2.5 Understand Concentric Constraint
 - 3.2.6 Understand Collinear Constraint
 - 3.2.7 Understand Horizontal Constraint
 - 3.2.8 Understand Vertical Constraint
 - 3.2.9 Understand Equal Constraint
 - 3.2.10 Understand Fix Constraint
 - 3.2.11 Understand Symmetric Constraint
 - 3.2.12 Understand Smooth Constraint
- 3.3 Explain Measurement

4. 3D Sketch

- 4.1 Understand Parameter
- 4.2 Understand 3D Sketching Entities

5. Solid Modeling

- 5.1 Modeling Tools
 - 5.1.1 Understand Extrude Feature
 - 5.1.2 Understand Revolve Feature
 - 5.1.3 Understand Holes Feature
 - 5.1.4 Understand Fillets Feature
 - 5.1.5 Understand Chamfers Feature
 - 5.1.6 Understand Ribs Feature
 - 5.1.7 Understand Thicken and Offset Feature
- 5.2 Explain Concept of Edit Feature
- 5.3 Advanced Modeling Tools
 - 5.3.1 Understand Sweep Feature
 - 5.3.2 Understand Lofted Feature
 - 5.3.3 Understand Coil Feature
 - 5.3.4 Understand Thread Feature
 - 5.3.5 Understand Shell Feature

- 5.3.6 Understand Face Draft Feature
- 5.3.7 Understand Replacing Face Feature
- 5.3.8 Understand Boundary Patch Feature
- 5.3.9 Understand Stitching Surfaces Feature
- 5.3.10 Understand Sculpt Feature
- 6. Assembly Modeling**
 - 6.1 Describe Types of Assembly
 - 6.2 Assembly Component
 - 6.2.1 Understand Mate Constraint
 - 6.2.2 Understand Angle Constraint
 - 6.2.3 Understand Tangent Constraint
 - 6.2.4 Understand Insert Constraint
 - 6.2.5 Understand Rotation Constraint
 - 6.2.6 Understand Rotation-Translation Constraint
 - 6.2.7 Understand Transitional Constraint
 - 6.3 Explain Editing of Assembly Constraint
- 7. Drawing View**
 - 7.1 Explain Types of Views
 - 7.2 Explain Drawing Standards
 - 7.3 Explain Drawing Sheets
 - 7.4 Explain Dimension Style
 - 7.5 Explain Parts Lists
- 8. Presentation Module**
 - 8.1 Explain Presentation View
 - 8.2 Explain Assembly Animation
- 9. Sheet Metal Components**
 - 9.1 Explain Sheet Metal Components Parameter
 - 9.2 Sheets Metal Components
 - 9.2.1 Understand Fold Feature
 - 9.2.2 Understand Flange Feature
 - 9.2.3 Understand Cut Feature
 - 9.2.4 Understand Corner Seam Feature
 - 9.2.5 Understand Bend Feature
 - 9.2.6 Understand Corner Round Feature
 - 9.2.7 Understand Corner Chamfer Feature
 - 9.2.8 Understand Hem Feature
 - 9.2.9 Understand Contour Flange Feature
- 10. CAM**
 - 10.1 Introduction of CAM
 - 10.1.1 Understand User Interface
 - 10.1.2 Understand Setup of materials
 - 10.1.3 Understand Setup of cutting tools
 - 10.1.4 Understand Strategy and cutting processes
 - 10.1.5 Understand Generating tool paths
 - 10.1.6 Understand Tool parts simulation
 - 10.2 2D CAM
 - 10.2.1 Describe Holes Drilling
 - 10.2.2 Describe Face cutting
 - 10.2.3 Describe Side cutting
 - 10.2.4 Describe Pocket cutting
 - 10.2.5 Describe Slot cutting
 - 10.3 CAM Milling

- 10.3.1 Rough cutting
 - 10.3.1.1 Describe Z level Roughing
 - 10.3.1.2 Describe Parallel Roughing
 - 10.3.1.3 Describe Plunge Roughing
 - 10.3.1.4 Describe Flat Roughing
 - 10.3.1.5 Describe Cutting Boundaries
 - 10.3.1.6 Describe Step over and leads
- 10.3.2 Finish cutting
 - 10.3.2.1 Describe Parallel Finishing
 - 10.3.2.2 Describe Z Level Finishing
 - 10.3.2.3 Describe Corner and Pencil Finishing
 - 10.3.2.4 Describe Iso line Finishing
 - 10.3.2.5 Describe Radial and Spiral Finishing
 - 10.3.2.6 Describe Flow line Finishing
 - 10.3.2.7 Describe Between 2 curves Finishing
 - 10.3.2.8 Describe Swarf Finishing
 - 10.3.2.9 Describe Cutting Finishing
 - 10.3.2.10 Describe Step over Finishing
- 10.4 CAM Lathe
 - 10.4.1 Explain Facing
 - 10.4.2 Explain Boring
 - 10.4.3 Explain Grooving
 - 10.4.4 Explain Threading (Inside and Outside)
 - 10.4.5 Explain Cut off
- 10.5 CAM Wire Cut
 - 10.5.1 Explain Die Cutting
 - 10.5.2 Explain Punch Cutting
 - 10.5.3 Explain Taper Cutting
 - 10.5.4 Explain 4 Axis Wiring Cutting
 - 10.5.5 Explain No Core Cutting
- 10.6 CAM Router
 - 10.6.1 Explain Contouring
 - 10.6.2 Explain Pocketing
 - 10.6.3 Explain Engraving
 - 10.6.4 Explain Chamfering
 - 10.6.5 Explain Raster to vector Translator
 - 10.6.6 Explain Nesting
- 10.7 CAM Multi-Axis
 - 10.7.1 Explain 4 Axis Milling
 - 10.7.2 Explain 5 Axis Swarf Milling
 - 10.7.3 Explain 5 Axis Index Drilling

List of Practical:

- | | |
|---|--------------|
| 1. Practice Sketch and Constrain | 10Hrs |
| 1.1 Draw Line | |
| 1.2 Draw Circle | |
| 1.3 Draw Ellipse | |
| 1.4 Draw Arc | |
| 1.5 Draw Rectangle | |
| 1.6 Draw Polygon | |
| 1.7 Place Points/Center Point | |
| 1.8 Create Fillet | |
| 1.9 Create Chamfer | |
| 1.10 Draw Spline | |
| 1.11 Create 3D Intersection Curve | |
| 1.12 Draw Helical curve | |
| 1.13 Add Perpendicular Constraint | |
| 1.14 Add Parallel Constraint | |
| 1.15 Add Tangent Constraint | |
| 1.16 Add Coincident Constraint | |
| 1.17 Add Concentric Constraint | |
| 1.18 Add Collinear Constraint | |
| 1.19 Add Horizontal Constraint | |
| 1.20 Add Vertical Constraint | |
| 1.21 Add Equal Constraint | |
| 1.22 Add Fix Constraint | |
| 1.23 Add Symmetric Constraint | |
| 1.24 Add Smooth Constraint | |
|
 | |
| 2. Practice Solid Modeling | 20Hrs |
| 2.1 Create Extrude | |
| 2.2 Create Revolve | |
| 2.3 Create Hole | |
| 2.4 Create Fillet | |
| 2.5 Create Chamfer | |
| 2.6 Create Rib | |
| 2.7 Create Thicken / Offset | |
| 2.8 Create Emboss | |
| 2.9 Create Decal | |
| 2.10 Create Sweep | |
| 2.11 Create Loft | |
| 2.12 Create Coil | |
| 2.13 Create Thread | |
| 2.14 Create Shell | |
| 2.15 Create Face Draft | |
| 2.16 Create Split | |
| 2.17 Create Boundary Patch | |
| 2.18 Create Trim and Extend Surface | |
| 2.19 Create Stitch Surface | |
| 2.20 Create Replace Face | |
| 2.21 Create Sculpt | |

3.	Practice Assembly Modeling	10Hrs
3.1	Practice Top Down Assembly	
3.2	Practice Bottom Up Assembly	
3.3	Practice Assemble parts with Mate Constraint	
3.4	Practice Assemble parts with Angle Constraint	
3.5	Practice Assemble parts with Tangent Constraint	
3.6	Practice Assemble parts with Insert Constraint	
3.7	Practice Assemble parts with Rotation Constraint	
3.8	Practice Assemble parts with Rotation-Translation Constraint	
3.9	Practice Assemble parts with Transitional Constraint	
4.	Practice Sheet Metal	14Hrs
4.1	Create Fold	
4.2	Create Flange	
4.3	Create Cut	
4.4	Create Corner Seam	
4.5	Create Bend	
4.6	Create Corner Round	
4.7	Create Corner Chamfer	
4.8	Create Hem	
4.9	Create Contour Flange	
5.	Practice Welds	8Hrs
5.1	Create Fillet Weld	
5.2	Create Cosmetic Weld	
5.3	Create Groove Weld	
6.	Practice 2.5D CAM	4Hrs
6.1	Create Tool path for Drilling	
6.2	Create Tool path for Side Cutting	
6.3	Create Tool path for Face Cutting	
6.4	Create Tool path for Pocket	
7.	Practice CAM Milling	10Hrs
7.1	Create Tool path for Z-Level Rough Cutting	
7.2	Create Tool path for Parallel Rough Cutting	
7.3	Create Tool path for Z-Level Finish Cutting	
7.4	Create Tool path for Parallel Finish Cutting	
7.5	Create Tool path for 3D Spiral Cutting	
7.6	Create Tool path for Corner Re-machining	
7.7	Create Tool path for Pencil Cutting	
7.8	Create Tool path for Horizon + Vertical Cutting	
8.	CAM Turn/Milling	10Hrs
8.1	Create Tool path for External / Internal Turning	
8.2	Create Tool path for External/Internal Threading	
8.3	Create Tool path for Engraving on Side Face	
8.4	Create Tool path for Drilling/Slotting on Side Face	
8.5	Create Tool path for Drilling/Slotting on External Face	
8.6	Create Milling Tool path on Side Face and External Face (Turn/Mill)	
8.7	Create Tool path for 4-Axies Rotary Milling	
9.	CAM Wire Cut	10Hrs
9.1	Create Profiling Tool path for Punch	
9.2	Create Profiling Tool path for Die	
9.3	Create Tool path for Side Cutting	

- 9.4 Create Tapered Profiling Tool path
- 9.5 Create Tool path for 4-Axies Wire (Punch/Die/Side)

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CAD / CAM

Practical Objectives:

1. Understand and master Sketch and Constrain Commands
2. Understand and master several Commands for Solid Modeling
3. Understand and master Assembly Modeling
4. Understand and master 3D Sheet Metal and open drawings
5. Understand and master 3D CAD for Welds
6. Understand and Practice Tool set-up
7. Understand and Practice Stock set-up
8. Understand Cutting Condition (Feed Rate, Spindle Speed)
9. Understand and Practice 2.5D CAM
10. Understand and Practice CAM Milling
11. Understand and Practice CAM Turn
12. Understand and Practice CAM Turn/Mill
13. Understand and Practice CAM Wire Cut
14. Understand and Practice Tool path Simulation
15. Understand Post set-up
16. Understand NC Code
17. Practice Cutting Strategy (Rough Cutting, Finish Cutting)
18. Understand Feature of CNC Machines

List of Machinery:

- | | | |
|-----------|--|---------------|
| 1. | 3D CAD Software (Solid Modeling) | 50-set |
| 2. | 3D CAM Software (Milling, Turning, Turn/Mill, Wire Cut) | 50 |
| 3. | Simulation Software for G Code | 50 |
| 4. | Computer | 50 |

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CNC MACHINES

Total Contact Hours		T	P	C
Theory	32	1	3	2
Practical	96			

AIMS At the end of this course the students will be able to:

- i) Understand G code, M code and several types of CNC Tooling System.
- ii) Operate Machining Center.
- iii) Operate Turning Center.
- iv) Operate Wire Cut

Course Contents:

1. Introduction to Numerical Control	1Hr
2. NC Machine Tool Characteristics	1Hr
3. Types of NC Machines Tools	6Hrs
4. Configuration and Control Method of NC Machine Tools	2Hrs
5. Accessories, Tools and Cutting Fluid	2Hrs
6. Program (Turning Center)	6Hrs
7. Program (Machining Center)	6Hrs
8. Automated Manufacturing System	2 Hrs
9. Condition for Cutting	2Hrs
10. Cutting Tools and Chips	2 Hrs
11. Selecting a Type of Tool Material	2 Hrs

Detail of Contents:

1. Introduction to Numerical Control	1Hr
1.1 Numerical Control Theory	
1.2 NC Machine Tool Operations	
2. NC Machine Tool Characteristics	1Hr
2.1 NC Machine Tool Characteristics and Types	
2.2 NC Machine Tool Structure, Names of Parts and Their Functions	
2.3 Use of NC Machine Tools	
3. Types of Machines Tools	6Hrs
3.1 Turning Center	
3.2 Machining Center	
3.3 NC Milling Machine	
3.4 Horizontal NC Boring and Milling Machine	
3.5 NC Drilling and Tapping Machine	
3.6 NC Hobbing Machine	
3.7 NC Grinder	
3.8 NC Tool Grinder	

3.9	NC Die-sinking Electric Discharge Machine	
3.10	Wire-cut Electric Discharge Machine	
3.11	NC Laser Machine Tool	
4.	Configuration and Control Method of NC Machine Tools	2Hrs
4.1	Positioning Control and Profile Control	
4.2	Servomechanism and Feedback Control	
4.3	Ball Screws	
4.4	Linear Motors	
4.5	Linear Motion Guides	
4.6	Tool Setting of Machining Centers	
5.	Accessories, Tools and Cutting Fluid	2Hrs
5.1	Machining Center Accessories	
5.2	Turning Center Accessories	
5.3	Tools (Machining Center)	
5.4	Tools (Turning Center)	
5.5	Cutting Fluid	
6.	Program (Turning Center)	6Hrs
6.1	Machining Process	
6.2	Tooling	
6.3	Coordinate System	
6.4	G-Code, M-Code	
7.	Program (Machining Center)	6Hrs
6.1	Machining Process	
6.2	Tooling	
6.3	Coordinate System	
6.4	G-Code, M-Code	
7.	Automated Manufacturing System	2 Hrs
7.1	DNC System	
7.2	FMC and FMS	
7.3	Networks (LAN)	
7.4	CIM, FA	
7.5	Robotics	
8.	Condition for Cutting	2Hrs
8.1	Classification of Machining Methods and Cutting	
8.2	Setting Cutting Conditions	
8.3	Cutting Finish Allowance	
8.4	Various Requirements Affecting a Finish Allowance	
8.5	How to Calculate Cutting Power	
9.	Cutting Tools and Chips	2Hrs
9.1	Names of Cutting Parts	
9.2	Effects of Each Nose Edge Portion	
9.3	Types and Applications of Cutting Tools	
9.4	Nominal Symbols of Tip	
9.5	Disposal of Chips	
10.	Selecting a Type of Tool Material	2 Hrs
10.1	Classification of Cutting Tool Materials	
10.2	High-speed Tool Steel	
10.3	Cemented Carbide Tool	
10.4	Coating High-speed Tool Steel	

- 10.5 Cermet
- 10.6 Ceramics
- 10.7 Polycrystalline Compacts
- 10.8 Selection of tools using ISO system

Recommended Textbooks:

- 1. The CNC Work Shop by Frank Nanfara (Publisher: SDC Publications, 2002)**
- 2. Fundamental Knowledge of Cutting, Technical Educational Publication in Japan**
- 3. Machining Center, Technical Educational Publication in Japan**
- 4. NC Machine Tools, Technical Educational Publication in Japan**
- 5. NC Lathe, Technical Educational Publication in Japan**

Instructional Objectives:

- 1. Introduction of Numerical Control**
 - 1.1 Describe Numerical Control Theory
 - 1.2 Describe NC Machine Tool Operation
 - 1.3 Describe History of NC Machine Tool Development
 - 1.4 Describe Production Trends of NC Machine Tools
- 2. NC Machine Tool Characteristics**
 - 2.1 Describe NC Machine Tool Characteristics and Types
 - 2.2 Describe NC Machine Tool Structure, Names of Parts and Their Functions
 - 2.3 Describe Use of NC Machine Tools
- 3. Types of Machines Tools**
 - 3.1 Explain Turning Center
 - 3.2 Explain Machining Center
 - 3.3 Explain NC Milling Machine
 - 3.4 Explain Horizontal NC Boring and Milling Machine
 - 3.5 Explain NC Drilling and Tapping Machine
 - 3.6 Explain NC Die-sinking Electric Discharge Machine
 - 3.7 Explain Wire-cut Electric Discharge Machine
 - 3.8 Explain NC Laser Machine Tool
- 4. Configuration and Control Method of NC Machine Tools**
 - 4.1 Describe Positioning Control and Profile Control
 - 4.2 Describe Servomechanism and Feedback Control
 - 4.3 Describe Ball Screws
 - 4.4 Describe Linear Motors
 - 4.5 Describe Linear Motion Guides
 - 4.6 Describe Tool Setting of Machining Centers
- 5. Accessories, Tools and Cutting Fluid**
 - 5.1 Describe Machining Center Accessories
 - 5.2 Describe Turning Center Accessories
 - 5.3 Describe Tools (Machining Center)
 - 5.4 Describe Tools (Turning Center)
 - 5.5 Describe Cutting Fluid
- 6. Program (Turning Center)**
 - 6.1 Explain Machining Process
 - 6.2 Explain Tooling and tool compensation
 - 6.3 Explain Coordinate System
 - 6.4 Explain G-Code, M-Code
- 7. Program (Machining Center)**
 - 7.1 Explain Machining Process
 - 7.2 Explain Tooling
 - 7.3 Explain Coordinate System
 - 7.4 Explain G-Code, M-Code
- 8. Automated Manufacturing System**
 - 8.1 Describe DNC System
 - 8.2 Describe FMC and FMS
 - 8.3 Describe Networks (LAN)
 - 8.4 Describe CIM, FA

8.6 Describe Robotics

9. Condition for Cutting

- 9.1 Explain Classification of Machining Methods and Cutting
- 9.2 Explain Setting Cutting Conditions
- 9.3 Explain Cutting Finish Allowance
- 9.4 Explain Various Requirements Affecting a Finish Allowance
- 9.5 Explain How to Calculate Cutting Power

10. Cutting Tools and Chips

- 10.1 Describe Names of Cutting Parts
- 10.2 Describe Effects of Each Nose Edge Portion
- 10.3 Describe Types and Applications of Cutting Tools
- 10.4 Describe Nominal Symbols of Tip
- 10.5 Describe Disposal of Chips

11. Selecting a Type of Tool Material

- 11.1 Explain Classification of Cutting Tool Materials
- 11.2 Explain High-speed Tool Steel
- 11.3 Explain Cemented Carbide Tool
- 11.4 Explain Coating
- 11.5 Explain Cermet
- 11.6 Explain Ceramics
- 11.7 Explain Polycrystalline Compacts

List of Practical:

- 1. Observe Safety Precautions of CNC Machines 3Hrs**
 - 1.1 General Safety Precaution for Machining Center, Turning Center and Wire Cut
 - 1.2 Machine Tool Safety Precautions for Machining Center, Turning Center and Wire Cut
 - 1.3 Warning and Marking Sign for Machining Center, Turning Center and Wire Cut
- 2. Observe Outline of Machine 6Hrs**
 - 2.1 Conception of Machines
 - 2.2 Profile Diagram and Main Part Name of Machining Center, Turning Center and Wire Cut
 - 2.3 Machine Specification of Machining Center, Turning Center and Wire Cut
 - 2.4 Tool Specification
 - 2.5 Controller Specification
 - 2.6 Hydraulic and Pneumatic System (Coolant, Air)
- 3. Operate Different Functions of Machines 9Hrs**
 - 3.1 Operational Panel Introduction of Machining Center, Turning Center and Wire Cut
 - 3.2 Operation Step of Machining Center, Turning Center and Wire Cut
 - 3.2.1 Switch On, Switch Off
 - 3.2.2 Work Piece Setting
 - 3.2.3 Adjusting and Zero Setting
 - 3.2.4 Setting Tools and Tool Holders
 - 3.2.5 Running Machines
- 4. Operate NC Program on Machining and Turning Center 15Hrs**
 - 4.1 Main Program and Sub Program
 - 4.2 Interpolation Functions
 - 4.3 Feed Functions
 - 4.4 Coordinate and Local Coordinate System
 - 4.5 Miscellaneous Functions (M Code)
 - 4.6 Cycle Functions
 - 4.7 Compensation Functions
 - 4.8 Programming for Robotics
- 5. Maintenance and Troubleshooting 9Hrs**
 - 5.1 Regular Inspection
 - 5.1.1 Inspection before Starting, After Starting and End of Daily Operation
 - 5.1.2 Weekly, Monthly, Seasonal and Annual Inspection
 - 5.2 Lubrication Method
 - 5.3 Cleaning and Replacement Method
 - 5.3.1 Cleaning of the Lubrication Oil Reservoir
 - 5.3.2 Air Filter
 - 5.3.3 Coolant Tank
 - 5.3.4 Cleaning and Replacement of hydraulic Tank
 - 5.3.5 Replacement of Spin-Oil Filter
 - 5.3.6 Assembly Precautions after Cleaning or Replacement
 - 5.3.7 Oil Cooler for Spindle Cooling
 - 5.3.8 Replacement Method for Spindle Cooling and Gear Box Lubricant
 - 5.4 Disposal of Waste Water, Oil and Waste Material
 - 5.5 Steel Belt Chip Conveyor
 - 5.6 Trouble Shooting for Circuit Control Parts
 - 5.7 Trouble Shooting for Piping

6. Operate Different CNC Machines

54Hrs

- 6.1 Operate Machining Center for following operations
 - 6.1.1 Drilling
 - 6.1.2 Tapping
 - 6.1.3 Reaming
 - 6.1.4 Shoulder Cutting
 - 6.1.5 Face Cutting
 - 6.1.6 Slot Milling
 - 6.1.7 Spot Milling
 - 6.1.8 Pocket Milling
 - 6.1.9 Open Pocket and Island Milling
 - 6.1.10 Core Milling
 - 6.1.11 Project and its inspection(Complete Part)
- 6.2 Operate Turning Center for following operations
 - 6.2.1 External / Internal Turning
 - 6.2.2 External / Internal Grooving
 - 6.2.3 External/Internal Threading
 - 6.2.4 Cut-Off
 - 6.2.5 Drilling/Slotting on Side Face
 - 6.2.6 Drilling/Slotting on External Face
 - 6.2.7 Milling on Side Face and External Face (Turn/Mill)
- 6.3 Operate Wire Cut for following operations
 - 6.3.1 Profiling for Punch
 - 6.3.2 Profiling for Die
 - 6.3.3 Side Cutting
 - 6.3.4 Tapered Profiling
 - 6.3.5 4-Axis Wire Cutting (Punch/Die/Side)

Practical Objectives:

- 1. Observe Safety Precautions of CNC Machines**
 - 1.1 Understand General Safety Precaution for Machining Center, Turning Center and Wire Cut
 - 1.2 Understand Machine Tool Safety Precautions for Machining Center, Turning Center and Wire Cut
 - 1.3 Understand Warning and Marking Sign for Machining Center, Turning Center and Wire Cut
- 2. Observe Outline of Machine**
 - 2.1 Understand Conception of Machines
 - 2.2 Understand Profile Diagram and Main Part Name of Machining Center, Turning Center and Wire Cut
 - 2.3 Understand Machine Specification of Machining Center, Turning Center and Wire Cut
 - 2.4 Understand Tool Specification
 - 2.5 Understand Controller Specification
 - 2.6 Understand Hydraulic and Pneumatic System (Coolant, Air)
- 3. Operate Different Functions of Machines**
 - 3.1 Understand Operational Panel Instruction of Machining Center, Turning Center and Wire Cut
 - 3.2 Understand Operation Step of Machining Center, Turning Center and Wire Cut
- 4. Operate NC Program on Machining and Turning Center**
 - 4.1 Understand Main Program and Sub Program
 - 4.2 Understand Interpolation Functions
 - 4.3 Understand Feed Functions
 - 4.4 Understand Coordinate and Local Coordinate System
 - 4.5 Understand Miscellaneous Functions (M Code)
 - 4.6 Understand Cycle Functions
 - 4.7 Understand Compensation Functions
 - 4.8 Understand Programming for Robotics
- 5. Maintenance and Trouble shooting**
 - 5.1 Understand and Practice Regular Inspection
 - 5.2 Understand Lubrication Method
 - 5.3 Understand Cleaning and Replacement Method
 - 5.4 Understand Disposal of Waste Water, Oil and Waste Material
 - 5.5 Understand Steel Belt Chip Conveyor
 - 5.6 Understand Trouble Shooting for Circuit Control Parts
 - 5.7 Understand Trouble Shooting for Piping
- 6. Operate Different CNC Machines**
 - 6.1 Operate Machining Center
 - 6.1.1 Practice and Master Drilling
 - 6.1.2 Practice and Master Tapping
 - 6.1.3 Practice and Master Reaming
 - 6.1.4 Practice and Master Shoulder Cutting
 - 6.1.5 Practice and Master Face Cutting
 - 6.1.6 Practice and Master Slot Cutting
 - 6.1.7 Practice and master Spot Cutting
 - 6.1.8 Practice and Master Pocket Milling
 - 6.1.9 Practice and master Open Pocket and Island Milling
 - 6.1.10 Practice and master Core Milling
 - 6.2 Operate Turning Center

- 6.2.1 Practice and Master External / Internal Turning
- 6.2.2 Practice and master External / Internal Grooving
- 6.2.3 Practice and Master External/Internal Threading
- 6.2.4 Practice and Master Cut-Off
- 6.2.5 Practice and master Drilling/Slotting on Side Face
- 6.2.6 Practice and Master Drilling/Slotting on External Face
- 6.2.7 Practice and Master Milling on Side Face and External Face (Turn/Mill)
- 6.2.8 Practice and Master 4-Axies Rotary Milling
- 6.3 Operate Wire Cut
 - 6.3.1 Practice and Master Profiling for Punch
 - 6.3.2 Practice and Master Profiling for Die
 - 6.3.3 Practice and Master Side Cutting
 - 6.3.4 Practice and Master Tapered Profiling
 - 6.3.5 Practice and Master 4-Axies Wire Cutting Punch/Die/Side)

List of Machinery:

1. Vertical Machining Center	3
2. Horizontal Turning Center	2
3. Wire Cut	1
4. Computer	10

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