## T.E. (Mechanical) Sandwich 2008 Course Structure
**(w.e.f. July – 2010)**

### Semester I

<table>
<thead>
<tr>
<th>CODE</th>
<th>SUBJECT</th>
<th>TEACHING SCHEME</th>
<th>EXAMINATION SCHEME</th>
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<td>Lect.</td>
<td>Pract / Dwg</td>
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<tr>
<td>302061</td>
<td>Elective I (Self Study)</td>
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<tr>
<td>302062</td>
<td>Seminar</td>
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<td>302063</td>
<td>Industrial In-plant Training</td>
<td>-</td>
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### SECOND TERM

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<th>EXAMINATION SCHEME</th>
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<td>302042</td>
<td>Heat Transfer*</td>
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<td>302064</td>
<td>Theory of Machine &amp; Machine Design –II**</td>
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<td>Turbo machines*</td>
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<tr>
<td>302065</td>
<td>Mechatronics</td>
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<td>Tribology</td>
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<td>302067</td>
<td>Metrology &amp; Quality Control</td>
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*Common to T.E. Mechanical Course

** Theory Paper of 4 Hours Duration

**Code**

- **302061 A** Production Management
- **302061 B** Behavioural Science
- **302061 C** Welding Technology
University of Pune, Pune  
T. E. (Mechanical) Sandwich Part I 2008 Course  
302061 (A): Production Management  
(Elective I) (Self study)  

Examination Scheme:  
Paper : 100 Marks

Section I

Unit I


**Organization:** Definition, Principles, Functions & Types of Organization.


Unit II

**Production Management**


Unit III


**Work Measurement**

**Time Study:** Aim & Objectives, Terminology & Tools, Use of stopwatch procedure in making Time Study. Time Study Forms, Performance rating, allowances and its types. Calculations of standard Time. Time study for indirect functions such as Maintenance & Marketing. Criticism of Time Study.

**Synthetic & Standard data Methods:** Concepts, Introduction to PMTS, MTM1, WFS, & Basic Motion Time Study. MTM2 & Other second Generation Methods, MOST.

Section II

Unit - IV

**Quality Control:** Definition of Quality, Quality Characteristics, Introduction to Quality Control, Study of control chart -control chart for variables, control chart for attributes. Acceptance Sampling - Sampling inspection v/s 100 percent inspection, Basic concepts, operating
characteristics curves, conflicting interests of consumer and producers, producer’s and consumer's risks, AQL, LTPD, AOQL, Single and Double Sampling Plans, Standard Sampling tables. Theory of Work Sampling

Unit - V
World Class Manufacturing-I: Deming’s and Juran’s Approach, Deming’s PDCA, PDSA cycle, 7 QC Tools, 5’S, TPM, Kaizen, Quality Circle, Concurrent Engineering, JIT, Kanban, Quality Function Deployment, House of Quality, Six Sigma, Poka Yoke

Unit - VI

Text Books:

Reference Books:

University of Pune, Pune  
T. E. (Mechanical) Sandwich Part I 2008 Course  
302061(B): Behavioural Science  
(Elective I) (Self study)  

Examination Scheme:  
Paper: 100 Marks  

Section I  
Unit I  
Factors affecting the operations of Enterprise: The purpose of an industrial enterprise in different industrial sectors—public, private, co-operative and small scale. External factors influencing and governing the enterprise—economic, political, technological and social. Statutory control—licensing, price control, wage legislation’s and other industrial laws, trade union’s role. Environment in the urban and rural laws.  

Unit II  

Unit III  
Industrial Behavior: Theories of motivation—Stimulus response, achievement, Affiliation and Maslow, Personality Traits, learning theories and self-improvement, effect on social and political environment.  

Section II  
Unit IV  
Organizational and group behavior: Small group behavior, formal and informal groups—Group dynamics. Organizational culture—Nature and causes of conflict—Interpersonal and inter-group conflicts—Resolution of conflicts. Role playing exercise—Transitional Analysis.  

Unit V  
Leadership: Leadership process and styles—Theory X and theory Y—Managerial Grid, continuous versus breakthrough improvements, Management of change, Quality awards models and role of self assessment.  

Unit VI  
Communication and inverting skills: Written communication—Oral and Nonverbal Communication. Different types of interview—Conducting an interview.  

Reference books:  
1. The Enterprises and Factors Affecting its operation, ILO Publication.  
3. Davies and Newstrom, “Organisational Behavior”.  
5. Peter Druncker, “The Practice of management”.  

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University of Pune, Pune  
T. E. (Mechanical) Sandwich Part I 2008 Course  
302061 (C): Welding Technology  
(Elective I) (Self study)  

Examination Scheme:  
Paper : 100 Marks  

Section I  

Unit I  
Gas welding processes and Equipments  
Definition, Oxy-acetylene welding, Principle of operation, Types of welding flames, Chemistry of oxy-acetylene flame, Lighting the torch, Flame adjustment, Gas welding technique, Base metal preparation, Welding techniques-Leftward and Rightward, Welding filler metal rods and fluxes, Gas welding equipment, Oxygen and acetylene cylinders, Acetylene generator, Manifold system and its advantages, Single stage and two-stage oxygen and acetylene pressure regulators, Oxygen and acetylene gas hoses and hose connections, Welding torches or blowpipes –low and high pressure type, Welding nozzles or tips, Gas lighter, Gas cylinder trolleys, Advantages of gas welding, Disadvantages of gas welding, Applications of gas welding, Oxy-hydrogen and other fuel-gas welding, Hydrogen, Propane, Butane and natural gas used for gas welding purposes, Air-acetylene welding, definition, principle of operation and Applications.  

Unit II  
Arc welding processes and Equipments  
Definition, Principle of the process, Principle of operation, Welding equipment, Joint design, Welding variables and parameters, Advantages, Limitations, and Applications for the processes like- Carbon Arc Welding, Flux Shielded Metal Arc Welding, Submerged Arc Welding, TIG (or GTAW) Welding, MIG (or GMAW) Welding, Flux Cored Arc Welding (FCAW), Electro slag Welding, Plasma Arc Welding, Arc Spot Welding, Welding Electrodes- Types of welding electrodes, Electrode details, Non-consumable or refractory electrodes, Consumable electrodes, Light, Medium and heavily coated electrodes, Categories of covered electrodes, Electrode coating ingredients and their functions, Manufacture of electrodes, Selection of electrodes, Care and storage of electrodes, Classification and coding of mild steel and low alloy steel electrodes, American system, British system and Indian system, Typical applications of covered electrodes.  

Unit III  
Resistance welding  
Definition, Fundamentals of electric resistance welding, Principle of operation, Equipment used, variables to be used, Variables in resistance welding. Advantages of resistance welding, Disadvantages of resistance welding, and applications of resistance welding for the processes like- Spot Welding, Seam Welding, Projection Welding, Resistance (Upset) Butt Welding, Flash butt Welding, Percussion Welding.  

Section II  

Unit IV  
Solid-state welding processes  
Definition, concept, Principle of operation, Equipment used, metal to be used variables in solid state welding. Advantages of solid state welding, Disadvantages of solid state welding, and
applications for the processes like - Cold (Pressure) Welding, Diffusion (Bonding) Welding, Ultrasonic Welding, Explosive Welding, Friction Welding and Inertia Welding, Forge Welding.

Special welding processes: Definition, concept, Principle of operation Equipment used, metal to be used Variables in special welding. Advantages of special welding, Disadvantages of special welding, and applications for the processes like - Thermit Welding, Atomic Hydrogen Welding, Electron Beam Welding, Laser Beam Welding

Unit V

Brazing and Soldering

Introduction, Comparison of soldering, brazing and welding, Definition of soldering. Principles of good soldering process, Soldering joint design, Soldering alloys, Selection of a soldering alloy, Soldering fluxes, cleaning the base metal surface, Soldering methods.


Unit VI

Defects in welds
Introduction, Cracks, Distortion, Incomplete penetration, Inclusions, Porosity and blowholes or gas pockets, Poor fusion, Poor weld bead appearance, Spatter, Under-cutting and over lapping, causes and remedies of defects.

Quality control in welding
Introduction, Quality assurance v/s Quality control, Weld quality, Discontinuities in welds, their causes and remedies and Quality conflicts.

Estimation of welding costs
Introduction, Main component costs of welding processes, Factors involved in welding costs, Basic costing procedure for arc welding, Solved and unsolved examples, Basic costing procedure for gas welding, Factors affecting welding cost, Solved and unsolved examples.

References:
2. Welding Technology – S.W. Nadkarni
5. Welding Handbooks – American Welding Society
6. Metal Hand Books – American Society of Metals
7. CO₂ Welding – British Welding Society
11. Modern Welding Technology, Carry, Prientice Hall
University of Pune, Pune  
T. E. (Mechanical) Sandwich Part I 2008 Course  
302062: Seminar

Examination Scheme:
Oral: 50 Marks

A Seminar is expected to be on a state-of-the-art technical topic related to Mechanical Engineering but outside syllabus. The Seminar report and its presentation is to be based on material, mainly collected and analyzed from the latest papers in technical Journals, Manuals, Manufacturers catalogue, Technical magazines, Reference books etc.

(Minimum 3 references are to be submitted along with seminar report).

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<tr>
<th>Component</th>
<th>Requirement</th>
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<tr>
<td>Report</td>
<td>Number of pages 15 to 20 (Soft copy and 1 hardcopy)</td>
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<td>Excluding a) Title b) Certificate c) Acknowledgement d) Abstract</td>
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<td>e) Index f) References. (Web site names should not be mentioned )</td>
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<td>Internal assessment</td>
<td>One mid term presentation by the student on the topic</td>
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<td>Examination</td>
<td>Two examiners, one internal and one external examiner.</td>
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<td>Marks are equally divided between Report and Presentation/ Oral. Presentation – Maximum 10 minutes, Question/Answer- Maximum 5 minutes</td>
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University of Pune, Pune
T. E. (Mechanical) Sandwich Part I 2008 Course
302063: Industrial In-Plant Training

Teaching Scheme:
½, Hours /Week/Student

Examination Scheme:
Term work : 150 Marks
Oral : 100 Marks

Duration of training in industry: 6 Months

GENERAL GUIDELINES
TO THE INSTITUTIONS RUNNING MECHANICAL ENGINEERING (SANDWICH) DEGREE COURSE
AND
TO THE STUDENTS OPTED FOR SANDWICH COURSE

Students are expected to learn following things during the Industrial In-plant Training of six months. He
shall be given training in large or medium size manufacturing unit in various departments.

1. Orientation / Rotational Training: Organizational structure of the Company, scale and type of
production, types of products, functional departments, like Manufacturing Process, Planning and
Control, Quality Assurance, Assembly, Testing, Maintenance, Stores, Purchase, Marketing, Human
resources Department, Design and Drawing Department, General Administration, Packing and
Dispatching, Tool Engineering, Materials and Material Handling etc.

2. Industrial Design and Drawing Practice: Design and Drawing standards, study of mechanical
components and component design such as gears, gear boxes, chain and belt drives, electric motor
selection, couplings, shaft, keys, bearings, brackets, bolted and welded connections. Sub-assembly
and assembly drawings. Simple assignments based on the above items, selection of material
specification, heat treatment, and properties of materials.

3. Study of Manufacturing Processes: Study of processes such as casting, forging, sheet metal working,
plastic moulding, extrusion, rolling, and machining operations on various machines, study of
finishing processes like grinding, lapping, honing, burnishing, buffing, etc. Chipless manufacturing
processes.

4. Study of Various Manufacturing Machine Tools such as lathes, capstan and turret lathes planer,
shaper, and milling. Mechanical and Hydraulic presses, Gear Hobbing, shaping and grinding
machines.

5. Study of special purpose machines, Jig boring machines, NC/CNC machines, work centers, and
transfer lines and automatic machines.

6. Study of single point cutting tools and multipoint tools form tools, Jig and fixtures, special purpose
machine tools. Tool material and tool selection, Study of cutting parameters.

7. Study of material handling methods and equipment.
8. Study of various inspection gauge, selection of type of gauge, comparators, calibration of gauges,
standards room etc. Product performance test procedures.
9. Study of processes and operation planning.

10. Study of safety gadgets used on machines, personal safety equipment, plant safety.

   The students shall be asked to do simple assignments in various departments where he is taking training. Industries shall be required to prepare training program beforehand, covering as much as possible from above mentioned topics depending upon the types of industry.

Term work

   Term work shall consist of a comprehensive report based on his observations, training received and assignments completed during 6 months of training. The report shall also include good drawings, figures, process sheets and machine and product specifications. Sandwich students shall obtain a certificate of successful completion of his training and his attendance from concerned industry and attach it to his report.

Examination:

   Oral examination shall be conducted after training by appointing one internal examiner and one external examiner from industry.
Teaching Scheme:
Lectures : 4 Hours/Week
Drawing : 2 Hours/Week

Examination Scheme:
Paper : 100 Marks
Term Work : 25 Marks
Oral : 50 Marks

Section I (A) THEORY OF MACHINE

Unit I

Synthesis of Mechanisms
Type, number & dimensional synthesis, Freudenstines equation, precision points, function
generation, path generation. Analytical and graphical synthesis of four bar mechanism and slider
crank mechanism. Body guidance, coupler curves.

Cams and Followers
Types, kinematic equivalent systems, follower motions, kinematic analysis and profile
construction of radial cams. Introduction to specified contour cams.

Unit II

Spur and Helical Gears
Spur gear - terminology, involute and cycloidal profile, conjugate action, interference,
undercutting. Friction between gear teeth. Helical gears - Normal and transverse module, virtual
number of teeth, force analysis, torque transmitted by helical gears.

Gear Trains
Types, velocity ratio, torque transmitted, holding torque.

Unit III

Gyroscope
Principles of gyroscopic action, precession, gyroscopic couple, effect of gyroscopic couple on
ships, airplane and vehicles etc.

Brakes and Dynamometers
Different types of brakes – shoe brakes, external and internal shoe brakes, band brakes,
bandand block brakes, braking torque. Dynamometers – absorption and transmission type,
construction, working principle, torque measurement.

Section II (B) MACHINE DESIGN

Unit IV

Design of Spur and Helical Gears
Gear tooth loads, formative number of teeth, effective load, estimation of module based on
different equations. Types of gear teeth failures, gear materials and constructional details.

Design of Bevel and Worm Gears
Design of bevel & worm and worm gears- terminology, applications, torque transmitted and
efficiency
Unit V

Friction and Friction Clutches
Pivot and collar friction, plate clutches, cone clutches, centrifugal clutches, torque transmitting capacity. Design requirements of friction clutches, selection criteria, materials. Design of single plate and multi plate clutches and cone clutches. Energy consideration and temperature rise.

Rolling Contact Bearings
Types, static and dynamic load capacity, stribek’s equation, load life relationship, selection of bearings. Design for variable loads and speeds. Lubrication, oil seal and packing, preloading, failure causes and remedies.

Unit VI

Design for Fluctuating Loads
Stress concentration-causes and remedies, Fluctuating stresses, Fatigue failure, S-N curve, Endurance limit, notch sensitivity, Endurance strength modifying factors, Reserved stresses, design for finite and infinite life, Cumulative damage in fatigue failure, Soderberg and Goodman diagram, Modified Goodman diagram, Fatigue design of components under combined stresses such as shafts, bolts, springs.

Term Work:

The term work shall consist of:
A – Three assignments on Theory of Machine part
B – Experiment on Gyroscope
C – ONE design project.

The design project shall consist of two full imperial size sheets - one involving assembly drawing with a part list and overall dimensions and the other sheet involving drawings of individual components, manufacturing tolerances, surface finish symbols and geometric tolerances should be specified so as to make it working drawing. A design report giving all necessary calculations of the design of components and assembly should be submitted in a separate file. (Preference should be given to Autocad)

Reference Books:

University of Pune, Pune
T. E. (Mechanical) Sandwich Part II 2008 Course
302065: Mechatronics

Teaching Scheme:
Lectures : 4 Hours/Week
Drawing  : 2 Hours/Week

Examination Scheme:
Paper     : 100 Marks
Term Work : 25 Marks
Oral      : 50 Marks

Section I

Unit I
Introduction to Sensors and Transducers
Introduction to Mechatronics, Measurement systems, Static characteristics, Classification of
Transducers and Sensors,
Basic Divider Circuits, Bridge Circuits, filters
Level measurement, strain measurement: Strain Gauge Principles, types, strain gauge circuits,
Load Cells, Temperature Compensation,
Temperature measurement : Thermister, RTD, Thermocouples

Unit II
Mechanical Sensors
Displacement & Position Sensors: Potentiometric Sensor, Capacitive and Inductive Sensors,
Variable Reluctance Sensors, Linear Variable Differential Transformers
Motion Sensors: Translational and Rotary Optical Encoders, Tachometers with output signal as
electrical quantity

Unit III
Converters and Controller Fundamentals
Data Acquisition system: concept of sampling, sample & hold operation, analog to digital
converters, digital to analog converters.
Introduction to SCADA & its application
System Models: Mathematical models, introduction to mechanical, electrical, fluid and thermal
systems. Rotational and transnational systems, Basic concepts of transfer function.

Section II

Unit IV
Controller Principles
Control Systems: Types of control system, Open loop, closed loop systems, transfer functions,
feed back and feed forward control systems and their applications
Process Characteristics: Process equation, Process load, Error, Variable range, Control Parameter
Range, Dead time.

Unit V
Controller Modes
Continuous Controller Modes: Proportional Controller, Integral Controller, Derivative Controller,
with mathematical equations, advantages, disadvantages and applications.
Composite Controller Modes: Proportional, Proportional + Integral (PI), Proportional +
Derivative (PD), Proportional + Integral + Derivative (PID) Controllers, with simple numerical
treatment.

Unit VI
Discrete State Process Control
Relay Controllers and Ladder Diagrams: Ladder Diagram Elements, and Ladder Diagram
Examples.
Programmable Logic Controllers: Relay sequencers, PLC Programming Concepts, logic, basic structure, input/output processing, timers, internal relays and counters, shift resisters, ladder diagram and programming, selection of PLCs, Case studies of Mechatronics with different applications like washing machine, dish washer, bottle filling plant, elevator, building automation.

List of Experiments
Minimum of 10 experiments from the following; out of which experiment no. 12 is compulsory, four shall be from serial no. 1 to 5, three from serial no. 6 to 11 and two from 13 to 17. Record of experiments and assignments shall be submitted in the form of journal.
2. Calibration of Thermocouples/RTD.
4. Study of various types of actuators.
5. Displacement measurement/level measurement.
6. Verification of P, P+I, P+D, P+I+D control actions.
7. Study of XY position control systems.
8. Study of linear conveyor control system.
9. Study of rotary table positioning systems.
10. Development of ladder diagram/programming PLC for level control, position control or any other mechanical engineering application.
11. Study of A/D and D/A converters.
12. Study of Flip Flops and Timers.
14. Study of Data acquisition system.
15. Study of switches & relays

Text Book

Reference Books
5. HMT, Mechatronics, HMT.
University of Pune, Pune
T. E. (Mechanical) Sandwich Part II 2008 Course
302066: Tribology

Teaching Scheme: Lectures : 4 Hours/Week
Examination Scheme: Paper : 100 Marks

Section I

Unit I

Unit II
Wear: Types of wear, various factors affecting wear, measurement of wear, wear between solids and liquids, theory of wear.

Unit III

Section II

Unit IV

Unit V
Lubrication of Plain Bearings: Ring oil Lubrication, Oil Circulation Systems, Maintenance of oil quality, contamination, Lubricant degradation, foaming, Warning and protective devices, Gears: Gear Surface finish, crankcase explosions, Reciprocating Compressors, Lubrication System

Unit VI
References:

University of Pune, Pune
T. E. (Mechanical) Sandwich Part II 2008 Course
302067: Metrology & Quality Control

Teaching Scheme: Examination Scheme:
Practical : 2 Hours/Week Term Work : 50 Marks

Students have to carry out Any Eight Experiments from the following:

1. Determination of Linear/ Angular dimensions of a part using precision/non precision measuring instruments.
2. Precision Angular Measurement using Sine bar/Sine center, Autocollimator/ Angle Dekkor. (any one)
3. Machine tool Alignment Test on any two machine like- Lathe, Milling, Drilling.(any 5 test one one machine)
6. Study & applications of profile projector.
7. Inspection of Production job by Statistical process control.
8. Design of GO and NOGO gauges by tailors principle
9. Quality control case study assignment poka- yoke /kaizen
10. Quality control case study assignment 5s /TPM /,TQM/pareto analysis

Reference Books:

5. Narayana K.L. Engineering Metrology
7. Francis T. Farago, Mark A. Curtis- Handbook of dimensional measurement.