# Savitribai Phule Pune University

## Structure and Syllabus

**FOR**

# B.E. Mechanical Engineering (Sandwich) 2012 Course

**UNDER FACULTY OF ENGINEERING**

## EFFECTIVE FROM June 2015

**Savitribai Phule Pune University, Pune.**

**B. E. Mechanical Engineering (Sandwich) Semester – I**

**(2012-Course; w.e.f. Academic year 2015 - 16)**

| Code | Subject | Teaching Scheme (Weekly Load in hrs) | | | Examination Scheme (Marks) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lect. | Tut | Practical | In-Sem | End-Sem | TW | PR | OR | Total |
| **402061** | Industrial In-plant Training | Two contact hour per student per week@ | | | -- | -- | 150 | -- | 100 # | **250** |
| **402062** | Project | -- | -- | -- | -- | -- | 100 | | 50# | **150** |
| **402063** | Technical Paper Presentation | -- | -- | -- | -- | -- | -- | -- | 50$ | **50** |
| **402064** | Automobile Engineering ( Self Study - III) | -- | -- | -- | -- | 100+ | 50 | -- | -- | **150** |
| **402065** | Power Plant Engineering ( Self Study – IV ) | -- | -- | -- | -- | 100+ | 50 | -- | -- | **150** |
| **Total of Semester – I** | | | | | | **200** | **350** | **--** | **200** | **750** |

@The contact hours are provided for supervision of students under training and for giving guidance regarding the project, technical paper presentation ,self study subjects and related term work during the training.
#Oral based on term work, will be conducted by internal and external examiner. External examiner shall be from industry.
$ Assessment by internal and external examiners. Presentation in front of examiners'.
+ Only end semester theory examination shall be conducted and there will not be in semester examination for self study subjects III & IV.

**B. E. Mechanical Engineering (Sandwich) Semester – II**

| Code | Subject | Teaching Scheme (Weekly Load in hrs) | | | Examination Scheme (Marks) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lect. | Tut | Pract. | In-Sem | End-Sem | TW | PR | OR | Total |
| **402066** | Mechanical Vibrations | 4 | -- | 2 | 30 | 70 | 25 | -- | 50 | **175** |
| **402067** | Industrial Hydraulics and Pneumatics | 4 | -- | 2 | 30 | 70 | 25 | -- | 50 | **175** |
| **402048** | Mechanical System Design* | 4 | -- | 2 | 30 | 70 | -- | -- | 50 | **150** |
| **402068** | Elective - I | 4 | -- | 2 | 30 | 70 | 50 | -- | -- | **150** |
| **402069** | Elective - II | 4 | -- | -- | 30 | 70 | | -- | -- | **100** |
| **Total of Semester – II** | | **20** | **--** | **8** | **150** | **350** | **100** | **--** | **150** | **750** |

| | Elective-I | | Elective-II |
|---|---|---|---|
| **Code** | **Subject** | **Code** | **Subject** |
| **402068 A** | Refrigeration and Air conditioning (Same as 402041 of Mech. Engg.) | **402069 A** | Energy Audit and Management (Same as 402044 A of Mech. Engg.) |
| **402068 B** | Computational Fluid Dynamics (Same as 402050 A of Mech. Engg.) | **402069 B** | Operations Research (Same as 402045 C of Mech. Engg.) |
| **402068 C** | Design of Pumps, blowers & Compressors (Same as 402050 C of Mech. Engg.) | **402069 C** | Robotics (Same as 402049 B of Mech. Engg.) |
| **402068 D** | CAD/ CAM Automation (Same as 402042 of Mech. Engg. without practical exam only term work ) | **402069 D** | Tribology (Same as 402044 B of Mech. Engg.) |
| | | **402069 E** | Open Elective** |

*Important Notes*

1. *In- sem theory examination will be conducted, approximately one and half month after the commencement of each semester.*
2. *In-Sem theory examination will be based on first three units from syllabus and will be conducted by the University.*

* Refer BE-Mech. Syllabus

**Open elective – Board of studies (BoS) – Mechanical will declare the list of subjects which can be taken under open elective or any other electives that are being taught in the current semester, to the same level, as elective – III under engineering faculty or individual college and industry can define new elective with proper syllabus using defined framework of elective IV and GET IT APPROVED FROM BOARD OF STUDIES AND OTHER NECESSARY STATUTORY SYSTEMS IN THE UNIVERSITY OF PUNE BEFORE DEADLINE (Say 30th November). Without approval from University statutory system, no one can introduce the open elective in curriculum.

# Savitribai Phule Pune University, Pune

B.E. Mechanical Engineering (Sandwich)

## Industrial In-plant Training

## (402061)

| Code | Subject | Teaching Scheme (Weekly Load in hrs) | | | Examination Scheme (Marks) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lect. | Tut | Pract. | Theory | | TW | PR | OR | Total |
| | | | | | In Sem. | End Sem. | | | | |
| 402061 | Industrial In-Plant Training | Two contact hour per student per week | | | - | - | 150 | - | 100 | 250 |

**Course Objectives:**

1. To make the student conversant with industrial activities, organizational behavior and ethics
2. To understand various industrial aspects viz. manufacturing processes, industrial design, productivity improvement, value engineering, quality control.
3. To analyze and solve engineering problems by correlating theory with industrial practices

**Course Outcomes:**

1. Development of professional ethics and ability to work in industrial environment.
2. Ability to understand various industrial aspects.
3. Ability of students to analyze and solve engineering problems by correlating theory with industrial practices.

*** Duration of training in industry: 6 Months***

GENERAL GUIDELINES

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

Studnets shall undergo industrial in-plant Training for the period of 6 months. Students shall be given training in large or medium size manufacturing unit in various departments. Students shall be placed preferably in the industry where he had undergone previous in-plant training. Organizations shall be required to prepare training program beforehand, covering as much as possible from the below mentioned topics depending upon the type of industry. Students shall be asked to do assignments in various departments. Students are expected to analyze the problems systematically and offer suggestions/ concluding remarks.

The training/ assignments may be related to following areas:

1. Machines/ process diagnostics.
2. Quality Assurance, quality improvement management.
3. Production planning and control, productivity improvement.
4. Costing and cost control, value engineering study.
5. Material inspection and movement, material management and control.
6. Inventory Control, stores, facility planning.
7. Improvement in tool layout, tool selection, machine selection.
8. Maintenance of m/s and maintenance of plants, housekeeping, safety precaution.
9. Plant layout, machine layout for minimum travel of the job, man and machine movement study time and motion study problems.
10. Computer based information study for stores, purchases, wastage of material, in process material planning and scheduling, assembly, storage of finish products, dispatch etc.
11. Placing a purchase order for inland/ foreign goods.
12. Import-export procedures.
13. Improvement of human skills, productivity.
14. Incentive schemes, labor laws, factory acts.

Term work shall consist of a comprehensive report based on student's observations, training received and assignments completed during six months of training. The report shall also include drawings, figures, process sheets, machine/ product specifications etc. Sandwich students shall obtain a certificate of successful completion of training from concerned industry.

**Examination:**

Term work assessment shall be done on regular basis. Organizations shall prepare assessment criteria and assessment schedule beforehand. Industry and College supervisors shall monitor the progress of students' in-plant training. College Supervisor shall receive a confidential assessment report of the student.

Oral based on term work, shall be conducted after successful completion of training by internal and external examiners. External examiner shall be from industry.

# Savitribai Phule Pune University, Pune

B.E. Mechanical Engineering (Sandwich)

# Project

# (402062)

| Code | Subject | Teaching Scheme (Weekly Load in hrs) | | | Examination Scheme (Marks) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lect. | Tut | Pract. | Theory | | TW | PR | OR | Total |
| | | | | | In Sem. | End Sem. | | | | |
| 402062 | Project | - | - | - | - | - | 100 | - | 50 | 150 |

## Course Objectives:

4. To apply theory knowledge to solve live industrial problem.
5. To understand the methodology to solve industrial problem in a systematic way.
6. To develop creativity and innovative approach.

## Course Outcomes:

4. Ability to correlate and implement theory knowledge to solve specific industrial problem.
5. Development of systematic approach to solve specific industrial problem.
6. Competency to face industrial problems confidently.

Student shall decide a suitable project in consultation with the industry authority. The scope of the project shall be such as to complete it within the stipulated training period.

Project progress review shall be taken on regular basis by college and industry.

Student shall maintain a project activity book.

## Project may be covering following industrial aspects:

1. Manufacturing/Fabrication of a proto-type machine including selection, concept, design, material, manufacturing the components, assembly of components. Testing and performance evaluation.
2. Improvement of existing machine/equipment/process.
3. Design and fabrication of Jigs and fixtures, dies, tools, special purpose equipment. Inspection gauges, measuring instruments for automats.
4. Computer aided design, analysis of components such as stress analysis.
5. Problems related Productivity improvements.
6. Problems related value engineering.

7. Problems related material handling systems.
8. Energy audit of a section in an organization/plant, Industrial waste and its control.
9. Design of a test rig for performance evaluation of machine device.
10. Product design and development.
11. Detail cost estimation of products.
12. Analytical evaluation and experimental verification of any mechanical engineering problems encountered.
13. Quality systems and management.
14. Low cost automation.

Student shall prepare and submit a detailed report based on project work.

**Examination:**

The oral examination shall be based on the Project work. The examination shall be conducted by an internal and an external examiner (External Examiner shall be from industry).

# Savitribai Phule Pune University, Pune

B.E. Mechanical Engineering (Sandwich**)**

# Technical Paper Presentation

# (402063)

| Code | Subject | Teaching Scheme (Weekly Load in hrs) | | | Examination Scheme (Marks) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lect. | Tut | Pract. | Theory | | TW | PR | OR | Total |
| | | | | | In Sem. | End Sem. | | | | |
| 402063 | Technical Paper Presentation | - | - | - | - | - | - | - | 50 | 50 |

**Course Objectives:**

7. To develop interest in research and advance technology.
8. To encourage the student to study new trends in engineering research.
9. To develop competency in understanding research in different areas of engineering.
10. To develop communication and presentation skills.

**Course Outcomes:**

7. Ability to understand advanced technology and research in engineering.
8. Development of communication and presentation skills.

A Technical paper presentation is expected to be on a state-of-the-art technical topic related to Mechanical Engineering but outside the syllabus. The report and its presentation should be based on literature, mainly collected and analyzed from the latest research papers from reputed national and international technical journals. (Minimum 3 research papers are to be submitted along with report).

| | |
|---|---|
| **Report** | Number of pages 15 to 20 (Soft copy and 1 hardcopy) |
| | Excluding a) Title b) Certificate c) Acknowledgement d) Abstract<br>e) Index f) References. (Web site names should not be mentioned ) |
| **Text** | Font size – 12<br>Font type – Times New Roman<br>Spacing – 1.5 |
| **Binding** | Spiral Binding |
| **Page size** | A 4 |
| **Internal assessment** | One mid term presentation by the student on the topic |
| **Examination** | Two examiners, one internal and one external examiner. External examiner is from Academics / Research Institutes. Marks are equally divided between Report and Presentation / Oral.<br>Presentation – Maximum 10 minutes,<br>Question/Answer- Maximum 5 minutes |

# Savitribai Phule Pune University, Pune

B.E. (Mechanical Sandwich) – (2012 Pattern)

# Automobile Engineering

## (402064) (Self study-III)

| Code | Subject | Teaching Scheme (Weekly Load in hrs) | | | Examination Scheme (Marks) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lect. | Tut | Pract. | Theory | | TW | PR | OR | Total |
| | | | | | In Sem. | End Sem. | | | | |
| 402064 | Automobile Engineering (Self Study) | -- | -- | -- | -- | 100 | 50 | -- | | 150 |

**Prerequisites:** Engineering Mechanics, Theory of machines, Basics of electronics

**Course Objectives:**

11. To make the student conversant with fundamentals of Automobile systems.
12. To develop competency in understanding of Automobile systems, its development and performance.
13. To make the student conversant with the automobile safety, automobile electronics and performance testing of automobiles.
14. To understand the various off road vehicles.

**Course Outcomes:**

9. Ability to understand the fundamentals of Automobile systems..
10. Ability to understand Automobile systems, its development and performance..
11. Ability to analyze automobile safety, automobile electronics and performance testing of automobiles.
12. Ability to understand construction and working of off road vehicles.

### Unit - I Introduction to Automobile Bodies

Automobile history and development, Classification, vehicle layout- engine location and drive arrangement, vehicle specifications.

**Vehicle Chassis System:** Types of vehicle bodies, types of Chassis (backward, forward, semi-forward controlled etc.), constructional details of chassis, frames, sub frames, frameless vehicles, defects in frames, vehicle dimensions, details of chassis material, Vehicle Classifications as per AIS.

**Axle:** Constructional details of front axle and rear axle, live and dead axles, live axle arrangement, single, double and triple reduction rear axle.

### Unit - II Automobile Transmission Systems

**Clutch:** Clutch Components (constructional details, materials, and types), various types of clutches, and different types of clutch actuations.

**Gear Box:** Gearbox necessity, functions of all resistances, tractive effort, performance curves, power required for acceleration and gradability, selection of gear ratio (numerical treatment), Types of gear box, Fluid flywheel and Torque convertor, CVT, IVT, overdrive.

**Transmission Line:** Effect of driving thrust and torque reaction, Propeller Shaft, Universal joints, final drive and its types, differential and its types.

**Wheels and Tyres:** Different types of wheels with Constructional details, Requirement of Wheel alignment and wheel balancing, types of tyres, tyre construction, tread design, failures and its causes.

## Unit- III Steering, Suspension and Brakes

**Steering Systems:** Steering mechanism, understeer and oversteer, steering geometry, centre point steering, cornering force, slip angle, scrub radius, steering characteristic, steering gearbox, Power steering, collapsible steering.

**Suspension Systems:** Sprung and unsprung mass, roll centre, factors affecting ride comfort, types of suspension linkages, type of springs (leaf, coil, air springs and torsion bar springs), damping and shock absorbers, rubber suspension, independent suspension, hydro elastic suspension, self levelling suspension (active suspension), hydro gas suspension.

**Brakes:** Types of brake systems (drum, disc), constructional details, Operation- mechanical, hydraulic, air brakes, servo and power braking, Stopping distance, Factors affecting brake performance, ABS.

## Unit - IV Automobile Safety and Electronics

Role of safety systems in automobiles, Active and passive safety, crashworthiness, Types of impacts, crash/roll over, importance of ergonomics in automobile safety, pedestrian safety and its importance, types of head restraints, air bags, seats, safety glass, mirrors, importance of bumpers, AIS regulations as per CMVR.

Fundamental of automotive electronic, Basic electronic control, Digital engine control system, Components of engine management system, Basic sensors arrangements and types, Automotive traction control, Automotive lamps and indicators, types, Horn, Windscreen wiper, Speedometers etc, Resent treads in automotive.

## Unit – V Vehicle Performance and Testing

Vehicle performance parameters, road resistance, traction and tractive efforts, power requirement for propulsion, road performance curves, Stability of vehicles, SAE vehicle axis system, vehicle body moments, roll over.

Vehicle road test, free acceleration test, coast down test, wheel test, Types of test tracks (high speed, pavement, corrugated, mud, steering, gradient etc.), different laboratory testing (testing on chassis dynamometers, accelerated virtual Evaporative emission , oil consumption etc.), crash testing and it's types, breaking distance test, battery testing, endurance testing.

## Unit VI Off-Road Vehicles

Constriction layout and application of off-road machine, multi-axle vehicles, different types of bulldozers, hydraulic dozers, dump truck-loaders, tankers and dumpers (single bucket, multi buckets and rotary type). General description, specification and function of light, medium and heavy wheeled tractors, constriction details of transport vehicle.

**Term Work: (Any eight from following and 7th no. is compulsory)**

1. Study of different vehicle layout and its comparison.
2. Study of different types of clutches and its comparison.
3. Study of different types of gearbox and its comparison.
4. study of differential and final drive.
5. Study of Semi automatic and automatic transmission.
6. Study of heavy duty vehicles and multi axle vehicles.
7. The assignment shall be internally presented in the form of power point presentation on recent automobile developments/advancements (2 nos.) A report of assignment (Max 8 to 10 pages) along with print out of PPT is to be submitted.
8. Industrial visit to any automotive manufacturer or auto ancillary industry and submission of detailed report.
9. Any one four wheeler vehicle review in detail and its comparison with any one competitor with detailed report.

**Reference Books**

1. K. Newton and W. Seeds, T. K. Garrett, "Motor Vehicle", 13th Edition, Elsevier publications.
2. Dr. Kripal Singh, "Automobile Engineering - Vol. 1", Standard publishers Distributors.
3. N. K. Giri, "Automobile Engineering", Khanna publications, Delhi.
4. Goering C. E., D. W. Smith, P. K. Turnquist, St. Joseph Mich "Off-Road Vehicle Engineering Principles", ASAE 2005.
5. SAE Manuals and Standards.

# Savitribai Phule Pune University, Pune

B.E. (Mechanical Sandwich) – (2012 Pattern)

# Power Plant Engineering

## (402065) (Self Study-IV)

| Code | Subject | Teaching Scheme (Weekly Load in hrs) | | | Examination Scheme (Marks) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lect. | Tut | Pract. | Theory | | TW | PR | OR | Total |
| | | | | | In Sem. | End Sem. | | | | |
| 402065 | Power Plant Engineering ( Self Study ) | -- | -- | -- | -- | 100 | 50 | -- | -- | 150 |

**Course Prerequisites:** Fundament of Thermodynamics & Heat Transfer**,** Basic Knowledge of Energy conversion.

**Course objectives**

1. To apply the laws of thermodynamics to formulate and solve engineering problems.
2. To get conversant with steam generator and its performance calculations
3. To understand the chemistry of combustion and analysis of combustion products.

**Course outcomes**

1. An ability to apply knowledge of Combustion, Thermodynamics and Heat transfer.
2. Ability to have development of energy conversion plants.
3. Ability to understand economic aspects of power generation.

**Unit - 01 Fuels and Combustion**:

Thermodynamic cycle of steam flow; Rankinecycle; Actual Rankine cycle; Reheat cycle; Carnot cycle, heat rate.Classification of fuels; calorific value and its determination; combustion chemistry, combustion equation;stoichiometric air fuel ratio; excess air requirement; actual air fuel ratio;flue gas analysis; pulverized coal firing system; fluidized bed combustion.

**Unit - 02 Thermal Power Plants**:

Types of boilers,& brief account of Lamont, Benson, Velox, Babcock & Wilcox boiler, Loeffer and Cochran Boiler, Feed water and its treatment, Steam turbine and alternators.
Site selection, Main parts and its working. Fuel Handling: delivery of load, unloading, preparation, transfer, outdoor (dead) storage, indoor (live) storage, In plant Handling, Coal weighing.

**Ash disposal and dust collation**: Draught systems, electrostatic precipitator Prospectus and development of thermal plants in India

**Unit - 03 Hydro Power Plant**:

Site selection, Hydrology, storage and bondage, general arrangements and operation of hydro power plant, Hydraulic turbines, turbine size, peltonwheel turbine, Francis and Kaplan turbines, selection of turbines, Dams,
Spillways, gates, intake and out take works, canals and layout of penstocks, Simple numerical on hydrographs and number of turbine required. Prospectus and development of hydro plants in India

**Unit - 04 Nuclear power plant:**

Introduction, atomic physics, nuclear reaction, materials, site selection, nuclear reactors and working of each part, classification of nuclear reactor, nuclear waste disposal, plant layout, Prospectus and development of
nuclear plants in India

**Diesel Power Plants:**

Introduction, Site selection, Plant Layout ,Main components and its working, Diesel plant efficiency and heat balance, choice and characteristic of diesel power plant.

**Unit - 05 Gas power plant:**

Simple gas turbine power plant, open loop and closed loop cycle power plants, gas fuels, gas turbine materials, plant layout.

**Non-conventional power plant**:

MHD plants, solar energy, fuel cells, tidal power generation, Bio mass(green energy ) plants ,geothermal power generation , wind power stations, Prospectus and development of non conventional power plants in India
Comparison of all power plants

**Unit - 06 Economics Aspects of Power Generation**:

Introduction, terms commonly used in system operations, factors affecting cost of generation, reduction of cost by interconnecting generators, choice of size and number of generator units, Input output curves of thermal and
Hydro power plants, Incremental fuel rate curves, incremental fuel cost curve, constraints on economic generation, economic loading of generators, load allocation among various generators, base load and peak load plants.

**Term Work**

**The term work shall consist of a record of any EIGHT of the following**

1. Study of boiler mounting and accessories.
2. Study of modern thermal power plant.
3. Study on diesel power plant.
4. Study of modern hydro electric power plant.
5. Study of solar photo voltaic system.
6. Study of Biomass system
7. Study on types of fluidized bed combustion
8. Study of a peloton wheel turbine, Francis and Kaplan turbines.
9. Assignment: simple numerical on hydrographs and number of turbine required
10. Assignment on Pollution from Thermal, Nuclear and hydro electric power plants (any two)

**Text Books**

1. P. K. Nag: Power Plant Engineering, Tata McGraw Hil
2. P. C. Sharma: Power Plant Engineering,
3. Chakrabarti, Soni, Gupta, Bhatnagar" A text book on power system Engineering" Dhanpat Rai publication
4. R.K.Rajput, "Power Plant Engineering"
5. J B Gupta, "Power Plant Engineering"

**Reference Books**

1. Arora and Domkundwar: A course in Power Plant Engineering, Dhanpat Rai publication
2. S. P. Sukhatme: Solar Energy

# Savitribai Phule Pune University, Pune

B.E. (Mechanical Sandwich) – (2012 Pattern)

# Mechanical Vibrations

# (402066)

| Code | Subject | Teaching Scheme (Weekly Load in hrs) | | | Examination Scheme (Marks) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lect. | Tut | Pract. | Theory | | TW | PR | OR | Total |
| | | | | | In Sem. | End Sem. | | | | |
| 402066 | Mechanical Vibrations | 4 | -- | 2 | 30 | 70 | 25 | -- | 50 | 175 |

**Prerequisites:** Engineering Mechanics, Theory of Machines

**Course Objectives:**

15. To make the student conversant with fundamentals of Mechanical Vibrations.
16. To develop competency in understanding of Mechanical Vibrations in Industry.
17. To develop analytical competency in solving Mechanical Vibrations problems.
18. To make the student conversant with natural frequencies, Eigen values & Eigen vectors.
19. To understand the various techniques of measurement and Mechanical Vibrations control.

**Course Outcomes:**

13. Ability to understand the fundamentals of Mechanical Vibrations.
14. Ability to develop analytical competency in solving Mechanical Vibrations problems.
15. Ability to understand measurement and control of Mechanical Vibrations.
16. Ability to calculate natural frequencies, Eigen values & Eigen vectors.
17. Ability to measure and control Vibrations for real life problems.

## Unit I: Balancing (8 Hrs)

Static and dynamic balancing, Balancing of rotating masses in single and several planes, Primary and secondary balancing of reciprocating masses,Balancing in single cylinder engines, Balancing in multi-cylinder in-line engines, Direct and reverse cranks method -Radial and V engines.

## Unit–II: Single Degree of Freedom Systems – Free Vibrations (8 Hrs)

**Fundamentals of Vibration:** Elements of a Vibratory System, vector representation of S.H.M., degrees of freedom, types of Vibration, Natural frequency, Equivalent springs, Modeling of a system, Formulation of equation of motion by equilibrium and energy methods.

**Undamped Free Vibrations:**Natural frequency for longitudinal, Transverse and Torsional Vibratory Systems.

## Unit–III: Single Degree of Freedom Systems – Damped Free Vibrations (6 Hrs)

Different types of damping, free vibrations with viscous damping - over damped, critically damped and under damped systems, Initial conditions, Logarithmic decrement, Introduction to equivalent viscous damping, dry friction or coulomb damping - frequency and rate of decay of oscillations.

### Unit–IV: Single Degree of Freedom Systems - Forced Vibration (10 Hrs)

**Forced Vibration:**Forced vibrations of longitudinal and torsional systems, Frequency Response to harmonic excitation, excitation due to reciprocating and rotating unbalance, base excitation, magnification factor, resonance phenomenon and phase difference, Quality Factor.

**Critical speed of shafts**: Introduction, Critical speed of shaft having single rotor of undamped systems.

### Unit–V: Two Degree of Freedom Systems-Undamped Vibrations (8Hrs)

Free vibration of spring coupled systems – longitudinal and torsional, natural frequency and mode shapes, Eigen value and Eigen vector by Matrix method, Geared systems. Introduction to Physical and Mathematical modeling: Motor bike and Quarter Car.

### Unit -VI: Measurement and Control of Vibrations (8Hrs)

**Vibration Measurements:** Force and Motion transmissibility, Vibration Measuring devices, Accelerometers, Impact hammer, Vibration shaker-Construction, principles of operation and uses, Vibration Analyzer, Analysis of Vibration Spectrum, Standards related to measurement of vibration and accepted levels of vibration.

**Vibration Control:** Introduction, vibration control methods, passive and active vibration control, reduction of excitation at the source, control of natural frequency, Vibration isolators, Dynamic Vibration Absorbers, Introduction to Torsional Damper.

## List of Experiments:

The Term Work shall consist of ***Eight Experiments*** *and* ***Two Assignments*** of following list.

**A] Compulsory Experiments ( Sr. No. 1 to 5) :**

1. Balancing of wheel / rotor on computerized balancing machine **OR** Demonstration of wheel balancing during a visit to industry / workshop.
2. To determine the natural frequency of damped vibration of single degree freedom system and to find it's damping coefficient.
3. To obtain frequency response curves of single degree freedom system of vibration for different amount of damping.
4. To determine natural frequency of transverse vibration of beam using vibration analyzer.
5. To determine critical speed of shaft with single rotor.

**B]** Any ***Three Experiments*** from the following :

1. To verify natural frequency of torsional vibration of two rotor system and position of node.
2. Experimental verification of principle of Dynamic Vibration Absorber.
3. Experiment on Shock Absorbers and to plot its characteristic curve.
4. Analysis of Machine Vibration Signature, using any analysis software package.
5. To plot motion transmissibility with base excitation using vibration shaker.

**C] Compulsory Assignments:**

1. Determination of free response of SDOF damped system to demonstrate different damping conditions using suitable software.
2. Determination of total response of SDOF damped system to harmonic excitation using suitable software.

## Text Books:


1. Rao S. S. "Mechanical Vibrations", Pearson Education Inc. Dorling Kindersley (India) Pvt. Ltd. New Delhi.
2. Grover G. K. "Mechanical Vibrations", Nem Chand and Bros.,Roorkee
3. Wiiliam J Palm III, "Mechanical Vibration" Wiley India Pvt. Ltd, New Delhi
4. UickerJ.John, Jr, Pennock Gordon R, Shigley Joseph E."Theory of Machines and Mechanisms" International Version, OXFORD University Press, New Delhi.
5. M L Munjal, " Noise and Vibration Control" Cambridge University Press India P Ltd., New Delhi


## Reference Books:


1. Thomson,W.T.,"Theory of Vibration with Applications", CBS Publishers and Distributors
2. V P Singh " Mechanical Vibrations DhanpatRai& Sons, New Delhi
3. DrDebabrata, " Mechanical Vibrations", Wiley India Pvt. Ltd, New Delhi.
4. Kelly S. G. "Mechanical Vibrations", Schaum's outlines, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
5. Meirovitch, "Elements of Mechanical Vibrations", McGraw Hill
6. Steinberg, D. S., "Vibration Analysis for Electronic Equipments", John Wiley and Sons.
7. ShrikantBhave, Mechanical Vibrations Theory and Practice, Pearson, NewDelhi.

# Savitribai Phule Pune University, Pune

B.E. (Mechanical Sandwich) – (2012 Pattern)

# Industrial Hydraulics and Pneumatics

# (402067)

| Code | Subject | Teaching Scheme (Weekly Load in hrs) | | | Examination Scheme (Marks) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lect. | Tut | Pract. | Theory | | TW | PR | OR | Total |
| | | | | | In Sem. | End Sem. | | | | |
| 402067 | Industrial Hydraulics and Pneumatics | 4 | -- | 2 | 30 | 70 | 25 | -- | 50 | 175 |

COURSE OBJECTIVES

1. To study governing laws in hydraulic and pneumatic systems.
2. To study working principles of various components used in hydraulic and pneumatic systems.
3. To understand the selection of different components used in hydraulic and pneumatic systems.
4. To design hydraulic and pneumatic systems.
5. To understand Industrial applications of hydraulic and pneumatic systems.

COURSE OUTCOMES

1. Ability to understand working principle of components used in hydraulic & pneumatic systems.
2. Ability to identify various components of hydraulic & pneumatic systems.
3. Ability to select appropriate components required for hydraulic and pneumatic systems.
4. Ability to design hydraulic and pneumatic system for industrial applications.
5. Ability to understand industrial applications of hydraulic and pneumatic system.

## Unit -1 Introduction to Hydraulics and Pneumatics (08)

Introduction to oil hydraulics and pneumatics, their structure, advantages and limitations. Properties of fluids, Fluids for hydraulic systems, governing laws. Distribution of fluid power, ISO symbols, energy losses in hydraulic systems.

Pumps

Types, classification, principle of working and constructional details of vane pumps, gear pumps, radial and axial plunger pumps, screw pumps, power and efficiency calculations, characteristics curves, selection of pumps for hydraulic Power transmission.

## Unit - II Actuators & Power units (08)

Hydraulic Actuators

(i) Linear and Rotary. (ii) Hydraulic motors - Types- Vane, Gear, Piston types, radial piston. (iii) Methods of control of acceleration, deceleration. (iv) Types of cylinders and mountings. (v) Calculation of piston velocity, thrust under static and dynamic applications, considering

friction, inertia loads. (vi) Design considerations for cylinders. Cushioning of cylinders. (Numerical treatment).

**Power units and accessories:** Types of power units, reservoir assembly, constructional details, pressure switches, temperature switches.

**Accumulators:** Types, selection/ design procedure, applications of accumulators. Types of Intensifiers, Pressure switches /sensors, Temperature switches/sensors, Level sensors.

## Unit - III Hydraulic Components (08)

Relief Valve-direct acting, pressure override, pilot operated (Two stage), vent operation.

Direction Control Valves- 4/2, 4/3, center positions, methods of actuation, center positions, two stage, mounting

Flow Control Valves- Pressure compensated, pressure and temperature compensated.

Pressure Control Valves- Pressure reducing valve, sequence valve, unloading valve, brake valve, back pressure valve, counter balance valve

Check Valves, Prefill Valve, Servo Valves, Cartridge Valves, Proportional Valves.

## Unit - IV Industrial Circuits& Contamination-Filtration (08)

Simple reciprocating, Regenerative, Speed control (Meter in, Meter out and bleed off), Sequencing, Synchronization, transverse and feed, circuit for riveting machine, automatic reciprocating, fail safe circuit, counter balance circuit, actuator locking, circuit for hydraulic press, unloading circuit (Numerical treatment), motor breaking circuit.

Contamination, sources of contamination, suction strainer, filters, filtration, filter ratings.

## Unit —V Pneumatics (08)

Principle of Pneumatics: (i) Laws of compression, types of compressors, selection of compressors. (ii) Comparison of Pneumatics with Hydraulic power transmissions. (iii) Types of filters, regulators, lubricators, mufflers, dryers. (iv) Pressure regulating valves, (v) Direction control valves, two way, three way, four way valves. Solenoid operated valves, push button, lever control valves. (vi) Speed regulating -

Methods used in Pneumatics. (vii) Pneumatic actuators-rotary, reciprocating.(viii) Air motors- radial piston, vane, axial piston (ix) Basic pneumatic circuit, selection of components, (x) Application of pneumatics in low cost automation and in industrial automation.

Introduction to vacuum and vacuum measurement, Vacuum pumps and its types, introduction to vacuum sensors and valves. Industrial applications of vacuum.

## Unit -VI System Design and trouble shooting (08)

Design of hydraulic/pneumatic circuits for practical application, Selection of different components such as reservoir, various valves, actuators, filters, pumps based on design. (Students are advised to refer manufacturers' catalogues)

Trouble shooting of pumps, relief valves, direction control valves.

## Term-Work

Minimum of 8 experiments and 2 assignments from the following; out of which serial no. 1 to 3 and 10 are compulsory, one from serial no 4 and 5 , three from serial no. 6 to 9 (For Design of system use any software like Automation Studio) and minimum 2 assignments from serial no. 11 to 14. Record of experiments, industrial visit and assignments shall be submitted in the form of journal.

1. Test on Gear/Vane/Piston pump and plotting of performance characteristics
2. Following experiments to be done on hydraulic trainer: a. Regenerative circuit b. Speed control circuit c. Sequencing circuit d. Transverse and feed circuit
3. Following experiments to be done on pneumatic trainer: a. Automatic reciprocating circuit b. Speed control circuit Pneumatic circuit involving shuttle valve/ quick exhaust valve
   d. Electro pneumatic valves and circuit
4. Test on pressure relief valve
5. Test on liner/rotary actuator
6. Design of accumulators and intensifiers in hydraulic system
7. Design of air distribution in pneumatic system
8. Design of simple hydraulic systems used in practice such as copy turning attachment, hydraulic clamps, jack, dumper, forklift etc.
9. Design of simple pneumatic systems used in practice such as braking system, vibrator, drilling, chisel etc.
10. Industrial visit to study automation by means of hydraulic and pneumatic system such as LPG bottling plant, hydraulic press, Injection moulding machines etc.
11. Assignment on ISO symbols for different components of Hydraulic and Pneumatic system
12. Assignment on different types of actuators used in Pneumatic and Hydraulic system
13. Assignment on trouble shooting procedures of various hydraulic and pneumatic systems
14. Assignment on selection of circuit components for simple hydraulic and pneumatic systems

## Text books


1. Esposito, Fluid Power with application, Prentice Hall
2. Majumdar S.R, Oil Hydraulic system- Principle and maintenance ,Tata McGraw Hill
3. Majumdar S.R ,Pneumatics Systems Principles and Maintenance ,Tata McGraw Hill
4. H.L.Stewart, Hydraulics and Pneumatics , Taraporewala Publication


## Reference books


1. J. J. Pipenger, Industrial Hydraulics, McGraw Hill
2. Pinches, Industrial Fluid Power, Prentice Hall
3. D. A. Pease, Basic Fluid Power, Prentice Hall
4. B. Lall, Oil Hydraulics, International Literature Association
5. Yeaple, Fluid Power Design Handbook
6. Andrew A. Parr, Hydraulics and Pneumatics, Elsevier Science and Technology Books.
7. ISO - 1219, Fluid Systems and components, Graphic Symbols
8. Michael J, Prinches and Ashby J. G, "Power Hydraulics", Prentice Hall.
9. Dr. R.K. Bansal, Fluid Mechanics, Laxmi Publication (P) Ltd.
10. Product Manuals and books from Vickers/ Eaton, FESTO, SMC pneumatics