।। सा विद्या या विमुक्तये ।।
स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड
"ज्ञानतीर्थ" परिसर, विष्णुपूरी, नांदेड - ४३१६०६ (महाराष्ट्र)
SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY NANDED
"Dnyanteerth", Vishnupuri, Nanded - 431606 Maharashtra State (INDIA)
Established on 17th September 1994 – Recognized by the UGC U/s 2(f) and 12(B), NAAC Re-accredited with 'A' Grade
25 1994 - 2019 SILVER JUBILEE YEAR

## ACADEMIC (1-BOARD OF STUDIES) SECTION

**Phone: (02462) 229542**
**Fax : (02462) 229574**
**Website: www.srtmun.ac.in**
**E-mail: bos.srtmun@gmail.com**

**विज्ञान व तंत्रज्ञान विद्याशाखेतील पदवी स्तरावरील द्वितीय वर्षाचे अभ्यासक्रम शैक्षणिक वर्ष २०१९–२० पासून लागू करण्याबाबत.**

# प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, **दिनांक ०८ जून २०१९ रोजी संपन्न झालेल्या ४४व्या मा. विद्या परिषद बैठकीतील ऐनवेळचा विषय क्र.११/४४–२०१९** च्या ठरावानुसार **प्रस्तुत विद्यापीठाच्या विज्ञान व तंत्रज्ञान विद्याशाखेतील** खालील विषयांचे अभ्यासक्रम शैक्षणिक वर्ष २०१९–२० पासून लागू करण्यात येत आहे.

1. B.E. – II Year – Mechanical Engineering
2. B.E. – II Year – Electrical Engineering
3. B.E. – II Year – Civil Engineering
4. B.E. – II Year – Computer Engineering

सदरील परिपत्रक व अभ्यासक्रम प्रस्तुत विद्यापीठाच्या **www.srtmun.ac.in** या संकेत–स्थळावर उपलब्ध आहेत. तरी सदरील बाब ही सर्व संबंधितांच्या निदर्शनास आणून द्यावी.

'ज्ञानतीर्थ' परिसर,
विष्णुपुरी, नांदेड – ४३१ ६०६.
**जा.क्र.:** शैक्षणिक–०१/परिपत्रक/विज्ञान व तंत्रज्ञान अभ्यासक्रम/२०१९–२०/**२४१**
**दिनांक** : २८.०६.२०१९.

स्वाक्षरित/–
**उपकुलसचिव**
शैक्षणिक (१–अभ्यासमंडळ) विभाग

प्रत माहिती व पुढील कार्यवाहीस्तव :

१) मा. कुलसचिव यांचे कार्यालय, प्रस्तुत विद्यापीठ.
२) मा. संचालक, परीक्षा व मूल्यमापन मंडळ यांचे कार्यालय, प्रस्तुत विद्यापीठ.
३) मा. प्राचार्य, सर्व संबंधित संलग्नित महाविद्यालये, प्रस्तुत विद्यापीठ.
४) उपकुलसचिव, पदव्युत्तर विभाग, प्रस्तुत विद्यापीठ.
५) साहाय्यक कुलसचिव, पात्रता विभाग, प्रस्तुत विद्यापीठ.
६) सिस्टम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ.

# Swami Ramanand Teerth Marathwada University,
# Vishnupuri, Nanded, MS – 431606, INDIA

**Curriculum for**

## B. E. (Second Year)

## MECHANICAL ENGINEERING

**(Undergraduate Degree Course)**

**(CGPA Revised)**

## Effective From: 2019 - 2020

**Teaching Scheme – B. E. (Second Year) Mechanical Engineering**

**SEMESTER – III** **Effective from 2019 - 2020**

| Sr. N | Category | Sub Code | Subject | Teaching Scheme | | | | Marking Scheme | | | | | Theory Total | Semester Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | TH | P | T | CR | PR | OR | TW | MSE | ESE | | |
| 1 | Basic Science Course | BSC – 301 | Physics II ( Optics & Waves) | 3 | 2 | | 4 | 25 @ | | 25 | 30 | 70 | 100 | 150 |
| 2 | Basic Science Course | BSC – 302 | Mathematics – III | 3 | | 1 | 4 | | | | 30 | 70 | 100 | 100 |
| 3 | Professional Core Course | PCC - ME 303 | Thermodynamics | 3 | 2 | | 4 | | 25 # | 25 | 30 | 70 | 100 | 150 |
| 4 | Engineering Science Course | ESC – 304 | Basic Electronics Engineering | 3 | 2 | | 4 | | | 25 | 30 | 70 | 100 | 125 |
| 5 | Engineering Science Course | ESC – 305 | Engineering Mechanics | 3 | 2 | | 4 | 25 @ | | 25 | 30 | 70 | 100 | 150 |
| 6 | Humanities and Social Sciences including Management Course | HSMC – 306 | Effective Technical Communication | 2 | | | 2 | | 25 @ | 25 | | | | 50 |
| 7 | Humanities and Social Sciences including Management Course | HSMC – 307 | Seminar – I | | 2 | | | | 25 @ | | | | | 25 |
| 8 | Mandatory Course | MC – 308 | Environmental Science (Mandatory Course) – Non Credit | 2 | | | | | | | 15 | 35 | 50 | 50 |
| **Semester Total** | | | | 19 | 10 | 1 | 22 | **50** | **75** | **125** | 165 | 385 | **550** | **800** |
| | | | | | | | | **125** | | | **550** | | | |

**TH – Theory , P– Practical, T – Tutorial , CR – Credit , PR – Practical OR – Oral , TW – Term work, MSE – Minor Semester Examination, ESE – End Semester Examination, @- Internal Assessment, # - External Assessment.**

**Teaching Scheme –B. E. (Second Year) Mechanical Engineering**

**SEMESTER – IV** **Effective from 2019 - 2020**

| Sr. N | Category | Sub Code | Subject | Teaching Scheme | | | | Marking Scheme | | | | | Theory Total | Semester Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | TH | P | T | CR | PR | OR | TW | MSE | ESE | | |
| 1 | Professional Core Course | PCC - ME 401 | Internal Combustion Engine | 3 | 2 | | 4 | | | 25 | 30 | 70 | 100 | 125 |
| 2 | Professional Core Course | PCC - ME 402 | Fluid Mechanics & Machinery | 3 | 2 | | 4 | 25 # | | 25 | 30 | 70 | 100 | 150 |
| 3 | Professional Core Course | PCC - ME 403 | Strength of Materials | 3 | 2 | | 4 | | | 25 | 30 | 70 | 100 | 125 |
| 4 | Professional Core Course | PCC - ME 404 | Mechanical Engineering Drawing | 2 | 4 | | 4 | 25 # | | 25 | 30 | 70 | 100 | 150 |
| 5 | Professional Core Course | PCC - ME 405 | Instrumentation & Control | 3 | 2 | | 4 | | | 25 | 30 | 70 | 100 | 125 |
| 6 | Basic Science Course | BSC – 406 | Biology for Engineers | 2 | | | 2 | | 25 @ | 25 | | | | 50 |
| 7 | Mandatory Course | MC – 407 | Professional Practice, Law and Ethics.( Non Credit) | 1 | 2 | | | | | 25 | | | | 25 |
| 8 | Humanities and Social Sciences including Management Course | HSMC – 408 | Management (Organizational Behavior) – Non Credit | 2 | | | | | | | 15 | 35 | 50 | 50 |
| | | | **Semester Total** | 19 | 14 | | 22 | **50** | **25** | **175** | 165 | 385 | **550** | **800** |
| | | | | | | | | **175** | | | **550** | | | |

**TH – Theory , P– Practical, T – Tutorial , CR – Credit , PR – Practical, OR – Oral , TW – Term work, MSE – Minor Semester Examination, ESE – End Semester Examination, @- Internal Assessment, # - External Assessment.**

# Mechanical Engineering
# Third Semester
# Curriculum Details

**Course Name : Second Year Mechanical Engineering**

**Semester : Third**

**Subject Title : Physics - II (Optics and Waves)**

**Subject Code : BSC - 301**

| Teaching Scheme ( in hrs ) | | | Total Credit ( TH +T+P) | Examination Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | Practical | | | Total |
| TH | T | P | CR | MSE | ESE | PR | OR | TW | |
| 3 | -- | 2 | 4 | 30 | 70 | 25@ | | 25 | 150 |

**Course Objectives:**

The course is designed to address the following:

1. To understand the Importance of applications of Applied Physics in daily life.
2. To provide students with a basic understanding of the Physics that may be required by engineers in the course of their careers.
3. To enhance knowledge related to Maxwell's Thermodynamics Equations and Radiation to make it suitable for various purposes.
4. To introduce most important concepts of Geometric optics, Waves motion to the students.
5. To introduce the learners to the basics of Oscillation and Simple Harmonic oscillators.

**Syllabus:**

**Module 1: Oscillation and Simple Harmonic oscillators (7 Hrs)**

Mechanical and electrical simple harmonic oscillators, complex number notation and phasor representation of simple harmonic motion, damped harmonic oscillator – heavy, critical and light damping, energy decay in a damped harmonic oscillator, quality factor, forced mechanical and electrical oscillators, electrical and mechanical impedance, steady state motion of forced damped harmonic oscillator, power absorbed by oscillator.

**Module 2: Waves motion (7 Hrs)**

Transverse wave on a string, the wave equation on a string, Harmonic waves, reflection and transmission of waves at a boundary, impedance matching, standing waves and their Eigen frequencies, longitudinal waves and the wave equation for them, acoustics waves and speed of

sound, standing sound waves. Waves with dispersion, water waves, superposition of waves and Fourier method, wave groups and group velocity.

**Module 3: Geometric optics (10 Hrs)**

Fermat's principle of stationary time and its applications e.g. in explaining mirage effect, laws of reflection and refraction, Light as an electromagnetic wave and Fresnel equations, reflectance and transmittance, Brewster's angle, total internal reflection, and evanescent wave, nodal slide and Newton's formula, Huygens and Ramsden's eyepieces. Mirrors and lenses and optical instruments based on them, transfer formula and the matrix method.

**Module 4: Wave optics (6 Hrs)**

Huygens' principle, superposition of waves and interference of light by wave front splitting and amplitude splitting; Young's double slit experiments, Michelson interferometer, Mach-Zehnder interferometer, the Rayleigh criterion for limit of resolution and its application to vision; resolving power of grating, telescope and prism.

**Module 5: Maxwell's Thermodynamics Equations and Radiation (8 Hrs)**

Maxwell's Thermodynamics Equations and Radiation: Maxwell's thermodynamical equations and their applications. Energy and heat capacity equations Clapeyron equations, Application to sublimation, vaporization and freezing processes, Heat capacity of saturated vapours. The blackbody spectrum, Wien's displacement law, Rayleigh-Jean's law, Planck's quantum theory of radiation.

**List of Experiments:**

1. To study the polarization of light and to find Brewster angle for a given glass.
2. Determine the refractive index of given liquid by using Newton's ring apparatus.
3. To determine the velocity of sound by using CRO.
4. To study normal mode of oscillations of coupled pendulums and to measure the normal mode frequencies.
5. To determine the acceleration due to gravity (g) by small oscillations of a bar pendulum.
6. To determine the angle of minimum deviation for a given prism by plotting the graph between angle of incidence and angle deviation.
7. To study the elliptically polarized light.
8. To find the resolving power of telescope.
9. Measurement of Planck's constant using black body radiation and photo-detector.
10. To determine the wave form and frequency of a given signal using C.R.O.
11. To determine slit width using He-Ne laser.
12. To determine Self Inductance of a Coil by Anderson's Bridge using AC.

13. To determine Self Inductance of a Coil by Rayleigh's Method.
14. To determine the Mutual Inductance of Two Coils by Absolute method using a Ballistic Galvanometer.
15. To determine g and velocity for a freely falling body using Digital Timing Technique.
16. To determine the value of g using Kater's Pendulum.
17. To determine the Moment of Inertia of a Flywheel.
18. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.

**Course Outcomes:**

After learning the course the students should be able to:

**CO 1** Expose the learners to different processes used in physics for industrial and technological applications.
**CO 2** Understand the importance of Applied Physics in physical phenomena.
**CO 3** Acquire Basic knowledge of Oscillation for Simple Harmonic, Mechanical and electrical simple harmonic oscillators.
**CO 4** Demonstrate knowledge of quantum mechanics and thermal physics.
**CO 5** Employ the knowledge of optical instruments mirrors and lens.
**CO 6** Implement the concept thermodynamical equations and their applications in various fields of geometric optics.

**Text Books:**


1. Text Book Of Simple Harmonic Motion And Wave Theory by D.K. Jha
2. Wave Optics – Suresh Garg, sanjay gupta and Ghosh.C.K.
3. Textbook of lasers in dermatology Koushik Lahiri,Abhishek M.D. & Aarti M.D
4. Thermal Physics: B.K. Agarwal.
5. Heat and Thermodynamics: Brij Lal and N. Subramanyam.


**Reference books:**


1. Ian G. Main, Oscillations and waves in physics
2. H.J. Pain, The physics of vibrations and waves
3. E. Hecht, Optics ADDISON WESLEY Publishing Company Incorporated, 2016
4. A. Ghatak, Optics McGraw-Hill Education, 23-Mar-2009
5. Heat and Thermodynamics: Dayal, Verma and Pandey.

**Course Name : Second Year Mechanical Engineering**

**Semester : Third**

**Subject Title : Mathematics - III**

**Subject Code : BSC - 302**

| Teaching Scheme ( in hrs ) | | | Total Credit ( TH +T+P) | Examination Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | Practical | | | Total |
| TH | T | P | CR | MSE | ESE | PR | OR | TW | |
| 3 | 1 | -- | 4 | 30 | 70 | -- | -- | -- | 100 |

**Course Objectives:**

The course is designed to address the following:

1. To introduce the solution methodologies for second order Partial Differential Equations with applications in engineering.
2. To compute distribution function and densities in field of engineering.
3. To differentiate correlation and regression concepts useful in applied engineering.
4. To introduce concept of basic elementary data of sampling.
5. To provide an overview of probability and statistics to engineers.

**Syllabus:**

**Module** 1: **Second-order linear equations** **(8 Hrs)**

Solutions of first order linear and second order homogenous and non-homogenous linear PDEs by complimentary function and particular integral method.

Second-order linear equations and their classification, Initial and boundary conditions, D'Alembert's solution of the wave equation; Duhamel's principle for one dimensional wave equation. Heat diffusion and vibration problems, Separation of variables method to simple problems in Cartesian coordinates. The Laplacian in plane, cylindrical and spherical polar coordinates, solutions with Bessel functions and Legendre functions. One dimensional diffusion equation and its solution by separation of variables.

**Module 2: Numerical Methods – I** **(6 Hrs)**

Solution of polynomial and transcendental equations – Bisection method, Newton-Raphson method and Regula-Falsi method. Finite differences, Relation between operators, Interpolation using Newton's forward and backward difference formulae. Interpolation with unequal intervals:

Newton's divided difference and Lagrange's formulae. Numerical Differentiation, Numerical integration: Trapezoidal rule and Simpson's 1/3rd and 3/8 rules.

**Module 3: Numerical Methods-II (6 Hrs)**

Ordinary differential equations: Taylor's series, Euler and modified Euler's methods. RungeKutta method of fourth order for solving first and second order equations. Milne's and Adam's predicator-corrector methods. Partial differential equations: Finite difference solution two dimensional Laplace equation and Poisson equation, Implicit and explicit methods for one dimensional heat equation (Bender-Schmidt and Crank-Nicholson methods), Finite difference explicit method for wave equation.

**Module 4: Transform Calculus (6 Hrs)**

Laplace Transform, Properties of Laplace Transform, Laplace transform of periodic functions. Finding inverse Laplace transform by different methods, convolution theorem. Evaluation of integrals by Laplace transform, solving ODEs and PDEs by Laplace Transform method.

**Module 5: Probability (8 Hrs)**

Bayes' rule, Random Variables: Discrete & continuous random variables, expectation, Variance, Probability Density Function & Cumulative Density Function. Moments & Moment generating function, Probability distribution: Binomial distribution, Poisson & Normal distribution, evaluation of statistical parameters for these three distributions (For detail study)

**Module 6: Statistics (8 Hrs)**

Correlation and regression – Rank correlation. Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves. Test of significance: Large sample test for single proportion, difference of proportions, Tests for single mean, t-distribution for dependent and independent samples, difference of means, and difference of standard deviations. Test for ratio of variances - Chi-square test for goodness of fit and independence of attributes.

**Course Outcomes:**

After learning the course the students should be able to:

**CO 1** Understand the solution methodologies for second order Partial Differential Equations.
**CO 2** Solve interpolation and integral using numerical methods.
**CO 3** Solve the Ordinary and Partial Differential Equations using Laplace Transformation.
**CO 4** Use the concept of correlation and regressions for statistical parameters.
**CO 5** Formulate and solve problems involving random variables and probability distribution.
**CO 6** Apply statistical methods for analyzing experimental data.

**Text Books:**

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9 th Edition, John Wiley & Sons, 2006.

2. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
3. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2003 (Reprint).
4. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.
5. Higher Engineering Mathematics by Grewal B. S. 38th edition, Khanna Publication 2005.
6. Operation Research by Hira & Gupta,S Chand.
7. A Text Book of Applied Mathematics Vol. I & II by P.N.Wartilar &
8. J. N. Wartikar, Pune, Vidyarthi Griha Prakashan., Pune.
9. Probability and Statistics for Engineering, Dr. J Ravichandran, Wiley-India.

**Reference Books**

1. Probability & Statistics with reliability by Kishor s. Trivedi, Wiley India.
2. Advanced Engg. Mathematics by C. Ray Wylie & Louis Barrett.TMH International Edition.
3. Mathematical Methods of Science and Engineering by Kanti B. Datta, Cengage Learning.
4. Advanced Engineering Mathematics by Kreyszig E. 9th edition, John Wiley.
5. Operations Research by S.D. Sharma Kedar Nath, Ram Nath & Co. Meerat.
6. Engineering optimization (Theory and Practice) by Singiresu S.Rao, New Age International publication.
7. Partial Differential Equations: Graduate Text in Mathematics" by Jurgen Jost
8. Partial Differential Equations" by L C Evans
9. Partial Differential Equations: Methods and Applications" by Robert C Mcowen.
10. Partial Differential Equations" by Fritz John.
11. Introduction to Probability" by P G Hoel.
12. Probability with Applications" by M Woodroofe.
13. Dr. M. Mazhar-ul-haque, Engineering Mathematics for Mechanical Engineering, 2019.

**Course Name : Second Year Mechanical Engineering**

**Semester : Third**

**Subject Title : Thermodynamics**

**Subject Code : PCC - ME 303**

| Teaching Scheme ( in hrs ) | | | Total Credit ( TH +T+P) | Examination Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | Practical | | | Total |
| TH | T | P | CR | MSE | ESE | PR | OR | TW | |
| 3 | -- | 2 | 4 | 30 | 70 | -- | 25# | 25 | 150 |

**Course Objectives:**

The course is designed to address the following:

1. Student should be able to identify and use units and notations in Thermodynamics.
2. State and illustrate first and second laws of Thermodynamics.
3. Explain the concepts of entropy, enthalpy, reversibility and irreversibility.
4. Apply the first and second laws of Thermodynamics to various gas processes and cycles.
5. To get conversant with properties of steam, dryness fraction measurement, vapor processes and Thermodynamic vapor cycles, performance estimation.
6. To get conversant with Psychrometric Charts, Psychrometric processes, human comfort conditions.

**Syllabus:**

**Module 1: Laws of Thermodynamics (6 Hrs)**

**a)** Introduction of thermodynamics, Review of basic definitions, Zeroth law of thermodynamics, Macro and Microscopic Approach, State Postulate, State, Process and Thermodynamic Cycles,

**b)** First law of thermodynamics, Joules experiment, Applications of first law to flow and non-flow processes and cycles. Steady flow energy equation and its application to different devices.

**c)** Second Law of thermodynamics, Equivalence of Clausius and Kelvin Planck Statement, PMM I and II, Concept of Reversibility and Irreversibility.

**Module 2: Entropy (6 Hrs)**

**a)** Entropy as a property, Clausius inequality, Principle of increase of Entropy, Change of entropy for an ideal gas and pure substance.

**b) Ideal Gas definition Gas Laws**: Boyle's law, Charle's law, Avagadro's Law, Equation of State, Ideal Gas constant and Universal Gas constant, Ideal gas processes- on P-V and T-S diagrams

Constant Pressure, Constant Volume, Isothermal, Adiabatic, Polytropic, throttling processes, Calculations of heat transfer, work done, internal energy. Change in entropy, enthalpy.

**Module 3: Thermodynamic cycles (8 Hrs)**

**a) Gas Power Cycles:** Air Standard Cycle, Efficiency and Mean Effective Pressure, Carnot

Cycle, Otto Cycle, Diesel cycle, Dual cycle, Comparison of cycles, Brayton cycle,

**b) Gas Refrigeration Cycle:** Reversed Carnot, Bell Coleman Cycle.

**c) Availability** Available and unavailable energy, concept of availability, availability of heat source at constant temperature and variable temperature, Availability of non flow and steady flow systems, Helmholtz and Gibbs function, irreversibility and second law efficiency.

**Module 4: Properties of Pure Substances and Thermodynamic Vapor cycles Properties of Pure substances (10 Hrs)**

**a)** Formation of steam, Phase changes, Properties of steam, Use of Steam Tables, Study of P-v, T-s and Mollier diagram for steam, Dryness fraction and its determination, Study of steam calorimeters (Barrel, Separating, Throttling and combined)

**b)** Non-flow and Steady flow vapor processes, Change of properties, Work and heat transfer.

**c) Vapor Power Cycles:** Carnot cycle, Rankine cycle, Comparison of Carnot cycle and Rankinecycle, Efficiency of Rankine cycle, Relative efficiency, Effect of superheat, boiler and condenser pressure on performance of Rankine cycle,

**d) Vapor Refrigeration Cycles:** Reversed Carnot Vapor Cycle, Vapor Compression Cycle and representation of cycle on P-h and T-S diagram, Refrigerating effect, Compressor power and Co estimation. **(Numerical Treatment using R134a only and enthalpy Cp, Cv data should be provided in tabulated form).**

**Module 5: Steam Generators (6 Hrs)**

**a)** Introduction to fuels, Theoretical amount of Oxygen / Air required for combustion. Stoichiometric Air: Fuel ratio, Excess air, lean and rich mixtures, Stoichiometric A: F ratio for petrol **(No Numerical Treatment on fuels and combustion, only basic definitions and terminologies to be covered)**.

**b)** Classification, Constructional details of low pressure boilers, Features of high pressure (power) boilers, Introduction to IBR, Boiler performance calculations-Equivalent evaporation, Boiler efficiency Energy balance, Boiler draught (natural draught numerical only).

**Module 6: Psychromety (4 Hrs)**

Psychrometry and Psychrometric Properties, Basic Terminologies, Psychrometric Relations, Psychrometric Chart, Psychrometric Processes, Thermodynamics of Human Body, Comfort Conditions **(Numerical treatment using Psychrometric chart only).**

**List of Experiments:-**

1) To Know about your Thermal Engineering Lab.
2) Joule's experiment to validate first law of thermodynamics.
3) Determination of Cp and Cv for Ideal gas.
4) Performance estimation of Air standard cycle using standard simulation software's (MATLAB, VC++ etc.).
5) Study of Barrel Calorimeter to determine dryness fraction of steam.
6) Study of Separating Calorimeter to determine dryness fraction of steam.
7) Study of Throttling Calorimeter to determine dryness fraction of steam.
8) Study of combined Separating and Throttling Calorimeter to determine dryness fraction of steam.
9) Experiment to Calculate COP of Simple Vapor Compression Cycle (VCC).
10) Performance estimation of VCC using any professional software (Cool Pack etc.)
11) Study of One high pressure Boiler.
12) Study of One Low pressure Boiler.
13) Study of Boiler Mountings.
14) Study of Boiler Accessories.
15) Trial on boiler to determine boiler efficiency, equivalent evaporation and Energy Balance.
16) Industrial visit to any process industry which uses boiler and submission of detailed report.
17) Demonstration of Psychometric processes (At least four).
18) Collect information and write a report on a Modern High Pressure boilers and its mounting and accessories.(Minimum Two).
19) Determination of calorific value of solid/liquid/gas fuel.
20) Mini project: Student will prepare individually a report on Renewable sources of energy and make power point presentation on the following.
    a) Any One Power Plant based on conventional energy sources.
    b) Bio gas, Bio mass and Bio Diesel as a fuel
    c) Wind, Tidal and Geothermal Energy.

**Course outcomes:**

After learning the course the students should be able to:

**CO1** Apply various laws of thermodynamics to various processes and real systems.
**CO2** Apply the concept of Entropy, Calculate heat, work and other important thermodynamic properties for various ideal gas processes.
**CO3** Estimate performance of various Thermodynamic gas power cycles and gas refrigeration cycle and availability in each case.
**CO4** Analyze the condition of steam and performance of vapour power cycle and vapour compression cycle.
**CO5** Understand Stoichiometric air required for combustion, performance of steam generators and natural draught requirements in boiler plants.

**CO6** Use Psychrometric charts and estimate various essential properties related to Psychrometry and processes.

**Text Books:**


1. P. L Ballany: Thermal Engineering, Khanna Publishers
2. C.P. Arora: Engineering Thermodynamics, Tata McGraw Hill.
3. Nag, P.K, 1995, Engineering Thermodynamics, Tata McGraw-Hill Publishing Co. Ltd.
4. R. K. Rajput, "Thermal Engineering", Laxmi Publications Pvt. Ltd, New Delhi.


**Reference Books:**


1. Y. Cengel & Boles: Thermodynamics – An Engineering Approach,

2. Sonntag, R. E. Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, Fundamentals of Thermodynamics, John Wiley and Sons.

2. Jones, J. B. and Duggan, R. E., 1996, Engineering Thermodynamics, Prentice-Hall of India

3. Moran, M. J. and Shapiro, H. N., 1999, Fundamentals of Engineering Thermodynamics, John Wiley and Sons.

4**.** S. Domkundwar, C. P. Kothandaraman, Anand Domkundwar, Thermal Engineering, Dhanpat Rai Publishers

5. B. K. Sarkar, "Thermal Engineering", Tata McGraw Hill Publishing Company Ltd. New Delhi.

7. P. K. Nag, "Engineering Thermodynamics", Tata McGraw Hill Publishing Company Ltd. New Delhi.

8. J. Selwin Rajadurai, "Thermodynamics and Thermal Engineering", New Age International

Publishers, New Delhi

9. D. S. Kumar, "Engineering Thermodynamics", S. K. Kataria & Sons, New Delhi.

10. Yunus A. Cengle, Michael A Boles - Thermodynamics An Engineering Approach, Mc Graw Hill

Book Company

11. Sonntag, Borgnakke & Van Wylen - Fundamental of Thermodynamics, Wiley Publishing

**Course Name : Second Year Mechanical Engineering**

**Semester : Third**

**Subject Title : Basic Electronics Engineering**

**Subject Code : ESC- 304**

| Teaching Scheme ( in hrs ) | | | Total Credit ( TH +T+P) | Examination Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | Practical | | | Total |
| TH | T | P | CR | MSE | ESE | PR | OR | TW | |
| 3 | -- | 2 | 4 | 30 | 70 | -- | -- | 25 | 125 |

**Course Objectives:**

The course is designed to address the following:

1. To provide an overview of electronic device components to Mechanical engineering students.
2. 1. Understand the scientific principles that apply to the basic flow of electricity and functions of semiconductor devices and their applications.
3. Identify the basic tools and test equipment to construct the given electronic circuit and system.
4. To understand the difference between analog and digital circuits and systems.
5. To evaluate the basic logic gate and verify its truth table.
6. To understand the amplitude and frequency modulation/demodulation

**Syllabus:**

**Module 1: Semiconductor Devices and Applications (6 Hrs)**

Introduction to P-N junction Diode and V-I characteristics, Half wave and Full-wave rectifiers, capacitor filter. Zener diode and its characteristics, Zener diode as voltage regulator. Regulated power supply IC based on 78XX and 79XX series, Introduction to BJT, it's input-output and transfer characteristics, BJT as a single stage CE amplifier, frequency response and bandwidth.

**Module 2: Operational amplifier and its applications (8 Hrs)**

Introduction to operational amplifiers, Op-amp input modes and parameters, Op-amp in open loop configuration, op-amp with negative feedback, study of practical op-amp IC 741, inverting and non-inverting amplifier applications: summing and difference amplifier, unity gain buffer, comparator, integrator and differentiator.

**Module 3: Timing Circuits and Oscillators (8 Hrs)**

RC-timing circuits, IC 555 and its applications as a stable and mono-stable multi-vibrators, positive feedback, Barkhausen's criteria for oscillation, R-C phase shift and Wein bridge oscillator.

**Module 4: Digital Electronics Fundamentals (10 Hrs)**

Difference between analog and digital signals, Boolean algebra, Basic and Universal Gates, Symbols, Truth tables, logic expressions, Logic simplification using K- map, Logic ICs, half and full adder/subtractor, multiplexers, de multiplexers, flip-flops, shift registers, counters, Block diagram of microprocessor/microcontroller and their applications.

**Module 5: Electronic Communication Systems (8 Hrs)**

The elements of communication system, IEEE frequency spectrum, and Transmission media: wired and wireless, need of modulation, AM and FM modulation schemes, Mobile communication systems: cellular concept and block diagram of GSM system.

**List of Experiments:**

1. To study and plot the characteristics of PN Junction diode.
2. To study and plot VI Characteristics of Zener Diode
3. Build and test zener diode as a voltage regulator
4. Plot input and output characteristics of a transistor in CE and CB configuration.
5. To observe input and output waveforms of Half, Full wave and Bridge Rectifier.
6. To plot the frequency response of single stage transistor amplifier..
7. To study the OPAMP as an inverting and non-inverting amplifier.
8. To verify NOT, OR, AND, NOR, NAND gates.
9. Built and Test half and Full adder circuit.
10. Design astable Multivibrator using IC555.
11. Design Monostable Multivibrator using IC555.
12. Design RC Phase Shift Oscillator.
13. Built and test Integrator circuit consisting of IC741
14. Observe the performance of wein bridge oscillator
15. Built and test regulated power supply using IC78XX.
16. Built and test regulated power supply using IC79XX.
17. Design simplex and duplex circuit.
18. Observe the waveforms of AM Modulation and Demodulation.
19. Build and test adder and subtractor using 741 OPAMP

**Course Outcomes:**

After learning the course the students should be able to:

**CO 1** Design an application using Operational amplifier.
**CO 2** Troubleshoot and maintain standard electronic circuits.
**CO 3** Design and verify the basic logic gate operations.
**CO 4** Design the basics of Electronic communication transmission medium circuits.
**CO 5** Understand the principles of semiconductor devices and their applications.
**CO 6** Be aware of the working of timing circuits and oscillators.
**CO 7** Analyze logic gates and flip flop as a building block of digital systems.
**CO 8** Learn the basics of Electronic communication system.

**Reference Books:**


1. David A. Bell, “Electronic Devices and Circuits”, Oxford University
2. Press, 5th Edition, 2008.
3. D.P. Kothari, I. J. Nagrath, “Basic Electronics”, McGraw Hill
4. Education (India) Private Limited, 2014.
5. Modern digital electronics’’ by R.P Jain
6. Linear Integrated circuit’’U.ABakshi,A,PGodse Technical publication,2010
7. Frenzel, “Communication Electronics: Principles and Applications”, Tata McGraw Hill, 3rd Edition, 2001


**Text books**


1 “principles of Electronics by V.K Mehta Rohit Mehta S Chand publication

2 “OP-AMPs and linear integrated circuit by Ramakant A Gayakwad

3 A textbook of Digital Electronics by S.S Bhatti Rahul Malhotra

4 Linear Integrated Circuits by D R O. Y. Choudhury, Shail B .Jain

**Course Name : Second Year Mechanical Engineering**

**Semester : Third**

**Subject Title : Engineering Mechanics**

**Subject Code : ESC - 305**

| Teaching Scheme ( in hrs ) | | | Total Credit ( TH +T+P) | Examination Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | Practical | | | Total |
| TH | T | P | CR | MSE | ESE | PR | OR | TW | |
| 3 | -- | 2 | 4 | 30 | 70 | 25@ | -- | 25 | 150 |

**Course Objectives:**

The course is designed to address the following:

1. To provide an introductory treatment of *Engineering Mechanics* to all the students of engineering, with a view to prepare a good foundation for taking up advanced courses in the area in the subsequent semesters.
2. A working knowledge of statics with emphasis on force equilibrium and free body diagrams.
3. Provides an understanding of the kinds of stress and deformation and how to determine them in a wide range of simple, practical structural problems.
4. Understanding of the mechanical behavior of materials under various load conditions. Lab should be taken concurrently.
5. Confidently tackle equilibrium equations, moments and inertia problems.
6. Master calculator/computing basic skills to use to advantage in solving mechanics problems.
7. Gain a firm foundation in Engineering Mechanics for furthering the career in Engineering

**Syllabus:**

**Module 1: Introduction to Engineering Mechanics (4 Hrs)**

Force Systems Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminacy

**Module 2: Friction (4 Hrs)**

Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack;

**Module 3: Basic Structural Analysis (6 Hrs)**

Equilibrium in three dimensions; Method of Sections; Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zero force members; Beams & types of beams; Frames & Machines;

**Module 4: Centroid and Centre of Gravity (8 Hrs)**

Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook.

**Module 5: Virtual Work and Energy Method (4 Hrs)**

Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and potential energy (elastic and gravitational), energy equation for equilibrium. Applications of energy method for equilibrium. Stability of equilibrium.

**Module 6: Review of particle dynamics (6 Hrs)**

Rectilinear motion; Plane curvilinear motion (rectangular, path, and polar coordinates). 3-D curvilinear motion; Relative and constrained motion; Newton's 2nd law (rectangular, path, and polar coordinates). Work-kinetic energy, power, potential energy. Impulse-momentum (linear, angular); Impact (Direct and oblique).

**Module 7: Introduction to Kinetics of Rigid Bodies covering, (4 Hrs)**

Basic terms, general principles in dynamics; Types of motion, Instantaneous centre of rotation in plane motion and simple problems; D'Alembert's principle and its applications in plane motion and connected bodies; Work energy principle and its application in plane motion of connected bodies; Kinetics of rigid body rotation;

**Module 8: Mechanical Vibrations: (4 Hrs)**

Basic terminology, free and forced vibrations, resonance and its effects; Degree of freedom; Derivation for frequency and amplitude of free vibrations without damping and single degree of freedom system, simple problems, types of pendulum, use of simple, compound and torsion pendulums;

**Tutorials**

To find the various forces and angles including resultants in various parts of wall crane, roof truss, pipes, etc.; To verify the line of polygon on various forces; To find coefficient of friction between various materials on inclined plan; Free body diagrams various systems including block-pulley; To

verify the principle of moment in the disc apparatus; Helical block; To draw a load efficiency curve for a screw jack.

**List of Experiments:**

Term work shall consist of record of laboratory/ practical work as listed below

1. Know your engineering mechanics laboratory equipments and apparatus.
2. Verify Law of moments.
3. Verify Lami's theorem by using universal force table.
4. Verification of law of polygon of force/parallelogram of forces.
5. Determination of coefficient of friction by inclined plane apparatus
6. To find the coefficient of friction between Belt and pulley friction
7. To find the moment of inertia of fly wheel.
8. Study of machines for calculation of MA, VR, Efficiency and Law of Machine for Single purchase crab
9. Study of machines for calculation of MA, VR, Efficiency and Law of Machine for Worm and worm wheel
10. Study of machines for calculation of MA, VR, Efficiency and Law of Machine for Screw Jack
11. Study of machines for calculation of MA, VR, Efficiency and Law of Machine for Different axle.
12. Study of machines for calculation of MA, VR, Efficiency and Law of Machine for Wheel of differential pulley block.
13. To compare coefficient of friction of various pair of surfaces in contact.
14. Assignments on Analytical solution of at least four problems on each unit based on above syllabus.

**Course Outcomes:**

After learning the course the students should be able to:

**CO 1** Use scalar and vector analytical techniques for analyzing forces in statically determinate structures.
**CO 2** Apply fundamental concepts of kinematics and kinetics of particles to the analysis of simple, practical problems.
**CO 3** Apply basic knowledge of mathematics and physics to solve real-world problems.
**CO 4** Know basic kinematics concepts – displacement, velocity and acceleration (and their angular counterparts).
**CO 5** Realize basic dynamics concepts – force, momentum, work and energy.
**CO 6** Understand and be able to apply Newton's laws of motion.
**CO 7** Apply basic dynamics concepts - the Work-Energy principle, Impulse-Momentum principle and the coefficient of restitution.
**CO 8** Recognize basic machine parts such as pulleys and mass-spring systems.

**Reference Books:**

1. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall

2. F. P. Beer and E. R. Johnston (2011), Vector Mechanics for Engineers, Vol I - Statics, Vol II, – Dynamics, 9th Ed, Tata McGraw Hill
3. R. C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press.
4. Andy Ruina and Rudra Pratap (2011), Introduction to Statics and Dynamics, Oxford University Press.

**Text Books:**

1. Shanes and Rao (2006), Engineering Mechanics, Pearson Education,
2. Hibler and Gupta (2010),Engineering Mechanics (Statics, Dynamics) by Pearson Education
3. Reddy Vijaykumar K. and K. Suresh Kumar(2010), Singer's Engineering Mechanics
4. Bansal R.K.(2010), A Reference Bood of Engineering Mechanics, Laxmi Publications
5. Khurmi R.S. (2010), Engineering Mechanics, S. Chand & Co.
6. Tayal A.K. (2010), Engineering Mechanics, Umesh Publications

**Course Name : Second Year Civil / Electrical / Computer / Mechanical Engineering. [All branches of B. E. Second Year]**

**Semester : Third**

**Subject Title : Effective Technical Communication**

**Subject Code : HSMC - 306**

| Teaching Scheme ( in hrs ) | | | Total Credit ( TH +T+P) | Examination Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | Practical | | | Total |
| TH | T | P | CR | MSE | ESE | PR | OR | TW | |
| 2 | -- | 0 | 2 | - | - | - | 25@ | 25 | 50 |

**Course Objective (s):**

The course is designed to address the following:

1. To improve technical drafting skills, comprehension abilities and make students communicate effectively in global context.
2. To facilitate the knowledge of technical proposals, drafts, reports, business correspondence, agendas, minutes, etc amongst the learners.
3. To inculcate effective speaking skills and enrich presentation skills by enhancing comprehension abilities of students.
4. To encourage innovative thinking, artistic drafting and elegant expressions both verbally and non-verbally amongst students.

**Syllabus:**

**<u>Module 1:</u> Self Development and Assessment (04 Hours)**

- Self Assessment and Awareness
- Perception, Attitude, and Belief System
- Self-esteem and Values
- Personal Goal Setting
- Career Planning and Assessment

**<u>Module 2:</u> Technical Writing, and Business Correspondence (06 Hours)**

**A] Technical Writing**

- Technical Writing: Meaning & Scope
- Technical Writing: purpose and objectives

- Drafting for print and online media.
- Basic Grammatical Errors

**B] Office Correspondence**

- E-mailing Etiquettes,
- Blog Writing
- Business Correspondence: Notices, Memos & Circulars, etc.
- Letter Writing: Formal and Personal
- Report Writing: Factual, Progress, Feasibility, Survey, etc.

**Module 3: Drafting, Revising and Editing Skills** **(08 Hours)**

**A] Drafting and Revising Skills:**

- Manuals, Brochures & Leaflets
- Articles & Business Proposals
- Newsletters and Magazines.
- Indexing Techniques

**B] Editing, and Proof Reading**

- Editing Techniques
- Translation Techniques.
- Note-Making Techniques.
- The Art of Condensation.
- Summarizing and Conclusion.

**Module 4: Professional Work Culture & Ethics** **(04 Hours)**

- Business Ethics & Morals
- Professional Work Culture
- Managing Time and Punctuality
- Conflict-management
- Problem-Solving Techniques

**Module 5: Public Speaking and Presentation Skills** **(06 Hours)**

**A] Public Speaking Skills**

- The Art of Public Speaking
- Group Discussion Skills
- Interview Techniques,
- Telephone Etiquettes
- Extempore, Elocution Techniques

**B] Presentation Skills**

- Presentation Skills
- Non-verbal Communication
- Power Point Presentation
- Using Audio-Visual Aids

**List of Practical / Assignments:**

1. Assessment of self perception, attitude, belief system and values by using worksheets, modals and charts.
2. Setting personal, professional goals and plan career by experimental activities in the classroom / labs.
3. Drafting activities based on con-current events, happenings for print as well as online media.
4. Identification and elimination of basic grammatical errors in sentences, paragraphs and content.
5. Drafting activity based on business correspondence, letter writing and report writing.
6. Drafting blog and emails for distinguished situations, in professional work culture.
7. Drafting, Editing and Proof Reading activities based on appropriate content in English.
8. Condensation, summarizing activities based on appropriated content in English.
9. Giving Presentations, seminars on suitable topic using PPTs to improve presentation skills.
10. Arrange elocution, extempore in the classroom on current topics in the social scenario.
11. Arrange group discussion, expert interview sessions, and mocks in the classroom.
12. Brain storming and problem-solving activities should be arranged in the classroom.

*Note: This is the suggestive list of assignments / practical to be conducted in the classroom / language lab. However, the subject teacher is free to set, design new assignment / practicals in relevance with the subject content.*

(Any eight assignments to be conducted and submitted to the subject teacher to form the record of the subject).

**Course Outcome (s):**

After studying the course, the student will be able to:

**CO 1** Accumulate, review, mediate accurate information and transmit technical ideas, policies with greater clarity & precision.

**CO 2** Draft, revise and edit technical drafts, letters, proposals, applications, with effective linguistic skills and abilities by eliminating grammatical errors in the same.

**CO 3** Absorb, inculcate and practice an industrial ethics, professional work culture and collaborate effectively in organizational communication system.

**CO 4** Lead, present and communicate business strategies persuasively and convincingly through result oriented endeavors both verbally and non-verbally within and outside organizations.

**Text Books:**


1. Meenakshi Raman and Sangeeta Sharma *Technical Communication Principles and Practice*, Third Edition. OXFORD University Press, New Delhi, 2015.
2. Dale Jung, k., *Applied Writing for Technicians*, McGraw Hill, New York, 2004. (ISBN: 07828357-4)
3. Sharma, R. and Mohan, K. *Business Correspondence and Report Writing*, TMH New Delhi 2002.
4. Dr. Alandkar, N. V. *Effective Communication Skills*, GRACE, Nanded, 2019.


**Reference Books:**


1. David F. Beer and David McMurrey, *Guide to writing as an Engineer*, John Willey. New York, 2004
2. Diane Hacker, Pocket Style Manual, Bedford Publication, New York, 2003. (ISBN 0312406843) Shiv Khera, *You Can Win*, Macmillan Books, New York, 2003.

**Course Name : Second Year Mechanical Engineering**

**Semester : Third**

**Subject Title : Seminar - I**

**Subject Code : HSMC - 307**

| Teaching Scheme ( in hrs ) | | | Total Credit ( TH +T+P) | Examination Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | Practical | | | Total |
| TH | T | P | CR | MSE | ESE | PR | OR | TW | |
| -- | -- | 2 | -- | -- | -- | -- | 25@ | -- | 25 |

**Course Objectives:**

1. The seminar learning objectives is to increase competency of the students.
2. Understand more vital issues of basic science.
3. To improve communication skills and stage courage of the students.
4. To understand the ethics of presentation and to get a scope of self improvement.

**Syllabus:**

This seminar is based on the recent advances in Basic Science. Student has to write a paper in a standard format on any recent topic pertaining to Basic science, mentioned below by referring different journals, books and other sources of information. Student has to prepare PPT of the same and present in front of a group of students and faculties who will be the observer of the presentation.

**Seminar Topics:**

1. **Polymers**

Introduction, Classification of polymers, addition polymerization, condensation polymerization, mechanism of addition polymerization, difference between thermoplastic and thermosetting resins, plastic, rubber, natural rubber, processing of latex, vulcanization of rubber. Bio degradable polymers, Basic methods of degradation.

2. **Composites**

Introduction, characteristics of composites, Specific strength, Application of composites, design principles and concepts, constituents of composite, Types of composites, fibre reinforced composites, carbon fiber, reinforced polymer composites, layered composites, Aramid reinforced polymer composites.

3. **Explosives and propellants**

Explosives, classification of explosive, primary explosives, 1000 explosives, High explosives, precautions during storage of explosives, blasting fuses. Manufacturer of Important Explosives, Rocket propellants, Classification of Propellants.

4. **Inorganic Engineering materials**

Abrasives, Natural abrasives, Artificial Abrasives, Refractories, properties of Refractories, manufacture of refractories, Common Refractory Bricks, cements, Insulating Refractories, Gypsum plaster, manufacturer of Portland cements, Chemical constituents of Portland cements, Glasses and Ceramics, manufacture of Glass, Types of Glasses.

5. **Semi Conductor**

Classification of metals, conductors, and semiconductors. Different types of semiconductors, semiconductor diode, p-n junction, application of junction diode as a rectifier, photo diode, light emitting diode, solar cell.

6. **Radiation**

Introduction, Electron emission, photoelectric effect, effect of intensity of light on photocurrent, Einstein's photo electric equation, Energy Quantum of Radiation.

7. **Fiber Optics**

Principles of work, definition, fiber class, Launching of light into an optical fiber, Numerical aperture of optical fiber, application of optical fiber in industry and in medicine, Optical fiber as sensor.

8. **Laser**

Principles of Laser, Einstein relation for spontaneous and stimulated emission. Microwave application by stimulated emission, Different types of Laser & their applications.

9. **Nuclear Energy:**

Mass energy equivalence, Nuclear binding energy, nature of Nuclear forces, energy released in nuclear reactor, nuclear fusion.

**10. Plant physiology**: Transpiration, Mineral nutrition.

**11. Ecology:**

Ecosystem components, types, flow of matter and energy in an ecosystem; Community ecology-characteristics, frequency, life forms and biological pyramids.

**12. Molecular Genetics:** Structure of DNA and RNA, CONCEPT OF Gene, Gene regulation, e.g., Operon concept. Biotechnology: Basic concepts. Totipotency and Cell manipulations, Plant and Animal tissue culture, methods and uses in agriculture, medicine and health, Recombinant DNA Technology-Techniques and applications.

**Course Outcomes:**

After studying the course, the student will be able to:

**CO1** Use multiple thinking strategies to examine real-world issues through self learning.

**CO2** Explore creative avenues of expression, solve problems, and make consequential decisions.

**CO3** Developing stage courage and confidence.

**CO4** Apply innovative thinking for best presentation.

**Course Name : Second Year Mechanical Engineering**

**Semester : Third**

**Subject Title : Environmental Science**

**Subject Code : MC - 308**

| Teaching Scheme ( in hrs ) | | | Total Credit ( TH +T+P) | Examination Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | Practical | | | Total |
| TH | T | P | CR | MSE | ESE | PR | OR | TW | |
| 2 | -- | -- | -- | 15 | 35 | -- | -- | -- | 50 |

**Course Objectives:**

The course is designed to address the following:

1. To make aware of the importance of Environment
2. To understand about natural resources and their contribution on human life
3. To understand eco system, biodiversity, pollution, and social issues related to environment.

**Syllabus:**

**Module 1: The Multidisciplinary nature of environmental studies**

Definition, scope and importance, Need for public awareness.

**Module 2: Natural Resources**

**Renewable and non renewable resources:**

a) Natural resources and associated problems

- Forest resources: Use and over-exploitation, deforestation, case studies, Timber extraction, mining, dams and their effects on forests and tribal people.
- Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dam's benefits and problems.
- Mineral Resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
- Food Resources: World food problems, changes caused by agriculture and over grazing, effects of modern agriculture, fertilizers-pesticides problems, water logging, salinity, case studies.

- Energy Resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies

- Land Resources: Land as a resource, land degradation, man induces landslides, soil erosion, and desertification.

b) Role of individual in conservation of natural resources.

**Module 3: Eco Systems**

- Concept of an eco system
- Structure and function of an eco system.

- Energy flow in the eco systems.
- Food chains, food webs and ecological pyramids.

**Module 4: Biodiversity and its Conservation**

- Introduction-Definition: genetics, species and ecosystem diversity.
- Biogeographically classification of India.
- Value of biodiversity: consumptive use, productive use, social, ethical, Aesthetic and option values

- Biodiversity at global, national and local level.
- India as a mega diversity nation.

**Module 5: Environmental Pollution**

Definition Causes, effects and control measures of:

a. Air pollution
b. Water pollution
c. Soil pollution
d. Marine pollution
e. Noise pollution
f. Thermal pollution
g. Nuclear hazards

Solid waste Management: Causes, effects and control measures of urban and industrial wastes

Role of an individual in prevention of pollution
Pollution case studies

Disaster management: Floods, earth quake, cyclone and land slides

**Module 6: Social issues and the Environment**

- Form unsustainable to sustainable development

- Urban problems related to energy

- Water conservation, rain water harvesting, water shed management

 Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies.

- Environment protection Act
- Air (prevention and control of pollution) Act
- Water (prevention and control of pollution) Act
- Wildlife protection act
- Forest conservation act
- Issues involved in enforcement of environmental legislations
- Public awareness

**Module 7: Human population and the environment**

- Environment and human health
- Role of information technology in environment and human health

**Module 8: Field work**

Visit to a local area to document environment assets such as river / forest / grassland / hill / mountain. Visit to a local polluted site-urban/rural/industrial/agricultural. Study of common plants, insects, birds. Study of simple ecosystems-pond, river, hills lopes, etc (field work equal to 5 lecture works)

**Course Outcomes:**

After learning the course the students should be able to:

**CO1.** Understand the basics of environmental science.

**CO2.** Learn about causes of different pollution and their remedies.

**CO3.** Learn about social issues that are connected to environment.

**CO4.** Apply knowledge for protection of environment.

**Text Books:**

**1.** Textbook of Environmental studies, Erach Bharucha, UGC

**2.** Fundamental concepts in Environmental Studies, D D Mishra, S Chand & Co Ltd

# Mechanical Engineering
# Fourth Semester
# Curriculum Details

**Course Name : Second Year Mechanical Engineering**

**Semester : Fourth**

**Subject Title : Internal Combustion Engine**

**Subject Code : PCC - ME 401**

| Teaching Scheme ( in hrs ) | | | Total Credit ( TH +T+P) | Examination Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | Practical | | | Total |
| TH | T | P | CR | MSE | ESE | PR | OR | TW | |
| 3 | -- | 2 | 4 | 30 | 70 | -- | -- | 25 | 125 |

**Course Objectives:**

The course is designed to address the following:

1. To study Engines performance parameters such as BMEP, Torque, BSFC and their relationship operating conditions
2. To study Ideal air standard cycles and fuel/air cycles
3. To understand roll of Parameters affecting volumetric efficiency, valve timing, port design.
4. To know about Turbo charging: compressor and turbine performance, matching components, introduction to impeller design.
5. To study combustion Processes in both spark and compression ignition engines: flame structure, cycle-to-cycle variation, knock, ignition, fuel injection, octane number, ignition delay, certain number.
6. To study Emissions: NOx, CO, UHC, Smoke, and Catalytic converters.
7. To analyze the performance of ramjets, turbojets, turbofans, and turboprops.

**Syllabus:**

**Module 1: Introduction and I.C. Engine Cycles (6 Hrs)**

Introduction, Basic engine components and nomenclature, Classification of I.C. Engines. Engine cycles, Deviation of actual cycles from air standard cycles, Valve timing diagram for high and low speed engines, Port timing diagram for two strokes S.I. Engines. Unavailable energy.

**Module 2: Fuel System for S.I. and C.I. Engines (10 Hrs)**

Engine fuel requirements, Carburetor and its various systems (Float, Idling and Acceleration system, Choke, Compensating system, Economizer), Derivation and calculation of A/F ratio,

Design of carburetor -Calculation of main dimensions of air and fuel supply, Effect of altitude on Air fuel ratio. Electronic Petrol injection system (MPFI) (Numerical calculations of main

dimensions of carburetor). Requirements of fuel injection system for S.I. engines, Fuel metering, pressurizing and injecting system, Types of injection systems- Individual pump, Common rail and Distributor systems, Module injector, Types of fuel nozzles- single hole, multi hole, pintle and pintaux, Formation of Spray, Atomization and penetration. Governing of C.I. engines, Pneumatic governors, Electronic control for diesel engine management, (Numerical on calculations of main dimensions of fuel injection system)

**Module 3: Air Induction (6 Hrs)**

Air induction: Supercharging-power required and effect on engine performance, different type of turbochargers. Purpose of supercharging, Thermodynamic cycle of supercharged engines, Types of superchargers, Turbo charging, Advantages and disadvantages, Limitations of supercharging for S.I. and C.I. Engines.

**Module 4: Combustion in S.I. and C.I. Engines (8 Hrs)**

Stages of combustion in S.I. engines, Ignition lag, Flame propagation, Factors affecting flame speed, Abnormal combustion, Influence of engine design and operating variables on detonation, Fuel rating, Octane number, Fuel additives, HUCR, Requirements of combustion chambers of S.I. Engines and its types. Stages of combustion in C.I. engines, Delay period, Factors affecting delay period, Abnormal combustion-Diesel knock, Influence of engine design and operating variables on diesel knock, Comparison of abnormal combustion in S I and C I engines, Cetane number, Additives, Requirements of combustion chambers for C.I. engines and its types.

**Module 5: Performance, Testing and Selection of I.C. Engines (6 Hrs)**

Performance parameters, Performance curves, I. S. Standard Code 10000 (I to XI) to 10004(for testing of engines), Measurement of performance parameters like torque, power, Volumetric Efficiency, Mechanical Efficiency, BSFC, Brake and Indicated Thermal efficiencies. Heat Balance Sheet. (Numerical on engine performance)Selection of an I.C. engine for Automotive, Locomotive, Aircraft, Marine, Agriculture, And Power generation based on criteria such as operating cycle, fuel used, cooling method, cylinder numbers and arrangement, speed, fuel economy and power to weight ratio.

**Module 6: Engine Emission and Control, Alternate Fuels and Engine Electronics (4 Hrs)**

S.I. engine emission (HC, CO, NOx) Control methods- ELCD, Thermal, Catalytic converters, C.I. Engines Emission (CO, NOx, Smog, Particulate), Control methods- Chemical, EGR, Standard pollution Norms. Alternative fuels for S. I. engines and C. I. engines, Blending, Use of CNG, Bio-gas, Non edible oils, Ethanol, Methanol, Hydrogen, Electronic engine management system.**).**

**List of Experiments:-**

1) To Know about your Power Developing Devices Lab.
2) Constructional details of I.C. Engines.
3) Study of Engine air inlet & exhaust systems.
4) Study of Lubrication systems for SI and CI Engines.

5) Study of cooling systems for SI and CI Engines.
6) Study of Ignition system and starting system.
7) Study of carburetor and petrol injection system.
8) Dismantling and assembly of I.C .engine.
9) Study of fuel injection system of diesel engine.
10) Study of Actual and theoretical Valve Timing diagrams for SI and CI Engines.
11) Study of Actual and theoretical P-V diagrams for SI and CI Engines.
12) Study of governing systems for SI and CI Engines.
13) Test on slow speed diesel engine.
14) Test on high speed diesel engine.
15) Test on variable speed four stroke petrol engine.
16) Morse test on multi cylinder engine.
17) Test on computerized I.C. engine test rig.
18) Measurement of I.C. engine emissions.
19) Measurement of frictional power using Willians Line Method.
20) Measurement of Calorific value of Fuels using Bomb Calorimeter/Orssat Apparatus.

**Term Work: Assignments**

Numeral's based on above syllabus

Record of at least three assignments preferably based on latest development in a particular field based on above syllabus. The students have to give a presentation on a selected topic in field of recent developments.

**Course Outcomes:**

After learning the course the students should be able to:

**CO 1** Relate the basic Thermodynamics, Heat Transfer with actual cycle analysis and actual losses in engine.
**CO 2** Recognize functioning and differences among fuel introduction systems of different engines also designs of fuel carburetor and design principles.
**CO 3** Understand the working and construction of turbocharging and supercharging.
**CO 4** Determine and understand the effects of spark timing, valve timing, A/F ratio, engine geometry, fuel type, and manifold on engine performance and emissions.
**CO 5** Prepare a performance report and emissions analysis of an internal combustion engine.
**CO 6** Plot performance characteristics curve during testing and to know about engine emissions.

**Text Books:**

1. Ganeshan, "Internal Combustion Engines" Tata Mac Hill Publication, 2nd edition.1999
2. Mathur and Sharma, "Internal Combustion Engines" DhanapatRai publication, 2nd edition, 2000.11. Sonntag, Borgnakke& Van Wylen - Fundamental of Thermodynamics, Wiley Publishing
3. I.C. engines by R.K.Rajput, LaxmiPublicaitons

4. I.C. engines by P.W. Gill, J.M. Smith, Oxford& IBH Publicaitons
5. I.C. engines by Lester Clyde, Lichty, MiGraw Hill Publicaitons
6. I.C. engines by Damkondwar.

**Reference Books:**

1. Obert E. F, "Internal Combustion Engines and Air Pollution", Harper and Row Publication Inc. NY, 1973.

2. Heisler H, "Advanced Engine Technology", Edward Arnold, 1995.

3. Heywood J. B, "Internal Combustion Engine Fundamentals", McGraw Hill Book Co. NY, 1989

4. Heldt P. M, "High Speed Combustion Engines", Oxford & IBH publishing Co. India, 1985.

5. Stockel M W, Stockel T S and Johanson C, "Auto Fundamentals", The Goodheart, Wilcox Co. Inc., Illinois, 1996.

3. Moran, M. J. and Shapiro, H. N., 1999, *Fundamentals of Engineering Thermodynamics*, John Wiley and Sons.

4. Nag, P.K, 1995, *Engineering Thermodynamics*, Tata McGraw-Hill Publishing Co. Ltd

**Course Name : Second Year Mechanical Engineering**

**Semester : Fourth**

**Subject Title : Fluid Mechanics and Machinery**

**Subject Code : PCC - ME 402**

| Teaching Scheme ( in hrs ) | | | Total Credit ( TH +T+P) | Examination Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | Practical | | | Total |
| TH | T | P | CR | MSE | ESE | PR | OR | TW | |
| 3 | -- | 2 | 4 | 30 | 70 | 25# | -- | 25 | 150 |

**Course Objectives:**

The course is designed to address the following:

1. To learn about the application of mass and momentum conservation laws for fluid flows.
2. To understand the importance of dimensional analysis.
3. To obtain the velocity and pressure variations in various types of simple flows.
4. To understand the applications of fluid mechanics in various fields such as automobile, airplane, mechanical systems, and spacecraft propulsion to microscopic biological systems.
5. To know the losses in flowing fluids in pipes.
6. To analyze the flow in water pumps and turbines.

**Syllabus:**

**Module 1: Fluid Statics (4 Hrs)**

Physical properties of fluids: Mass density, specific weight, specific volume, specific gravity, viscosity, surface tension, vapour pressure and their influence on fluid motion. Atmospheric pressure, gauge pressure and vacuum pressure.

Measurement of pressure: Piezometers, U-tube and differential manometers – mechanical pressure gauges. Buoyancy, centre of buoyancy, stability of floating bodies, metacentre and metacentric height, its application in shipping.

**Module 2: Fluid Kinematics (6 Hrs)**

Classification of flows Ideal fluid and real fluid – steady and unsteady flows, uniform and non-uniform flows, laminar and turbulent flows, rotational and irrotational flows. One dimensional, two dimensional, three dimensional flows.

Equation of continuity for one-dimensional flows, velocity of fluid particle. Laplace's equation in velocity potential and Poisson's equation in stream function flow net.

**Module 3: Fluid Dynamics** **(6 Hrs)**

Various forces acting on a fluid element- Euler's and Bernoulli's equation for flow along a streamline, momentum equation and its applications for pipe bend problem.

Closed conduit flow – Reynolds number, Reynolds experiment – "Darcy –Weisbach" equation – Minor losses in pipes – pipes in series and pipes in parallel – total energy line – hydraulic gradient line, measurement of flow: Pitot tube, venture meter, orifice meter & flow nozzle meter

**Module 4: Flow through Pipes** **(3 Hrs)**

Friction factor and Losses in pipes.

**Module 5: Impact of Jets** **(6 Hrs)**

Introduction, force exerted by fluid jet on stationary flat plate, normal to the Jet and inclined to the Jet, force exerted by fluid Jet on moving flat plate, force exerted by a fluid Jet on moving curved vane. Torque exerted on a wheel with radial curved vanes. Jet propulsion of ships.

**Module 6: Hydraulic Turbines** **(8 Hrs)**

Classification of turbines - Impulse and reaction turbines, 1.Pelton wheel 2. Francis turbine and Kaplan turbine – working principles, work done, efficiencies, hydraulic design, draft tube theory, functions and efficiency ( numerical to calculate efficiency, work done etc)

**Module 5: Pumps** **(8 Hrs)**

Classification Pump, working of centrifugal pump, work done manometric head – losses and efficiencies – specific speed – pumps in series and parallel –performance characteristic curves, NPSH. Working of Reciprocating pumps, discharge, slip, percentage slip, and Indicator diagram, effect of acceleration and friction on the ideal indicator diagrams.

**List of Experiments:**

1. Determine Pressure and Discharge (Q) through pipes, channels.
2. Determine the absolute pressures and gage pressures.
3. Determine pressure changes using manometers.
4. Determine forces on submerged plane, center of pressure.
5. Determine buoyancy for a body completely or partially submerged in a fluid.
6. Verify Bernoulli's theorem.
7. Determine Cd, Cc & Cv for orifice.
8. Determine discharge by using Venturimeter.
9. Calculate discharge by using Orifice meter.

10. Calculate velocity & discharge by using Pitot tube.

11. Determine the Reynold's number for laminar and turbulent flow.

12. Determine major frictional losses for circular pipes.

13. Determine the energy loss through various types of pipes of minor losses.

14. Determine the coefficient of resistance for various types of minor losses.

15. Determine net positive suction head.

16. Calculate the efficiency of pelton wheel turbine.

17. Determine the efficiency of centrifugal pump.

18. Determine the efficiency of reciprocating pump.

**Course Outcomes:**

After learning the course the students should be able to:

**CO1** Develop basic knowledge on Fluid Statistics, Dynamics, and Hydro-electric power stations.

**CO2** Apply principles of fluid mechanics to the operation, design, and selection of machinery.

**CO3** Mathematically analyze simple flow situations.

**CO4** Estimation of efficiency, performance of pumps and turbines.

**CO5** Design and planning of Hydroelectric Power plant with the available water resources and requirement of power.

**CO6** Identify, formulate and solve problems related to fluids at rest and in motion.

**CO7** Knowledge to design pipeline systems, floating bodies and hydraulic gates.

**CO8** Knowledge to design pipeline systems, floating bodies and hydraulic gates.

**Text Books:**

1. Fluid Mechanics And Hydraulic Machines – Dr. R. K. Bansal
2. Hydraulics & Fluid Machines – Dr. P. N. Modi & Seth

**Reference Books:**

1. Fluid Mechanics and Hydraulic Machines – K. R. Arora
2. Fluid Mechanics and Hydraulic Machines – Dr. D. S. Kumar
3. Fluid Mechanics and Hydraulic Machines – R. K. Rajput
4. Fluid Flow Machines – N. S. Govinda Rao
5. Turbo machines – Shames
6. Centrifugal and Axial Flow Pump – Step Anoff
7. Hydraulic Machines – Jagdish Lal
8. Hydraulic Machines – V. P. Vasamdani

**Course Name : Second Year Mechanical Engineering**

**Semester : Fourth**

**Subject Title : Strength of Material**

**Subject Code : PCC - ME 403**

| Teaching Scheme ( in hrs ) | | | Total Credit ( TH +T+P) | Examination Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | Practical | | | Total |
| TH | T | P | CR | MSE | ESE | PR | OR | TW | |
| 3 | -- | 2 | 4 | 30 | 70 | -- | -- | 25 | 125 |

**Course Objectives:**

The course is designed to address the following:

1. To understand the mechanical properties of material, for selecting suitable material for engineering application.
2. To understand the concepts of various stresses and their significant effects to design the different engineering machine parts.
3. To analyze the shear force and bending moment diagrams to design beam and loading condition.
4. To understand the nature of stresses developed in simple geometries such as bars, cantilevers, beams, shafts, cylinders and spheres for various types of simple loads
5. To calculate the elastic deformation occurring in various simple geometries for different types of loading.

**Syllabus:**

**Module 01: Simple Stress and Strain (6 Hrs)**

a) Simple Stresses and Strains: Mechanical properties of materials, analysis of internal forces, simple stress and strain, stress-strain curve, Hooke's law, modulus of elasticity, shearing stress, Poisson's ratio, volumetric stress, bulk modulus, shear modulus, relationship between elastic constants.

b) Thermal stresses

c) Strains and deformation in determinate and indeterminate homogeneous and composite bars under concentrated loads

d) Buckling of Column

Concept of critical load and buckling, Derivation of Euler's formula for buckling load with various end conditions, limitations of Euler's formula, Rankine buckling load, Safe load on column.

**Module 02**: **Principal Stresses and Strains** **(4 Hrs)**

a) Concept of principal stresses and principal plane Normal& shear stress on any oblique plane & concept of principal plane, principal planes by analytical methods

b) Graphical method. (Mohr's circle for a 2-D stress state).

c) Strain Energy: Strain energy and resilience: Load deflection diagram, strain energy, proof resilience, stresses due to gradual, sudden and impact loadings, shear resilience, strain energy in terms of principal stresses

**Module 03**: **Shear force and bending moment** **(6 Hrs)**

a) Concept and definition of shear force and Bending Moment in beams due to concentrated load, UDL, and couples in determinate beams.

b) Relation between SF, BM and intensity of loading,

c) Construction of SF and BM diagrams for cantilevers, simple compound beams

**Module 04**: **Bending and shear Stresses in beams** **(6 Hrs)**

a) Bending Stresses**:** Theory of simple bending, Concept and assumptions, Derivation of flexure formula, Bending stresses distribution diagram, Different IS steel section, Flitched beams, Design of a section.

b) Shear Stress in Beams**:** Concept and derivation of shear stress distribution formula, Shear stress distribution diagram for symmetrical and unsymmetrical section.

**Module 05: Direct and bending stresses** **(6 Hrs)**

a) Introduction, Concept of Axial, Eccentric load, Direct Stress

b) Stress distribution for an eccentric loaded rectangular section,

c) Middle third rule, core or kernel section, circular solid and hollow section, structural section.

**Module 06: Torsion of Circular Shaft** **(4 Hrs)**

a) Theory of torsion of shaft of circular cross section,

b) Assumptions made in torsion

c) Derivation of torsion formulae, d) Stress in shaft of hollow, solid, composite circular cross section subjected to twisting moments, Stresses due to combined torsion, bending and axial force on shaft.

**Module 07: Thin & Thick Pressure Vessels** **(4 Hrs)**

a) Thin pressure vessels: Stress, Strain and deformation in thin walled seamless cylindrical and spherical vessels.

b) Thick pressure vessels: Lame's theory, Stresses in thick cylindrical shell and compound cylinder, Initial difference of radii at the junction of compound tube,

c) Stresses in thick spherical shell.

**Module 8: Deflection of Beams (4 Hrs)**

a) Concept of deflection

b) Slope and deflection by double integration method (Macauley's method).

c) Slope and deflection for simply supported, cantilever and statically determinate beam

**List of Experiments:**

1. Know your laboratory to understand the different machines and their purpose available in the laboratory.
2. Understand different components, their purpose and operation of 'universal Testing Machine '
3. Understand different components, their purpose and operation of 'Extensometer'
4. Tension test on mild steel specimen by using UTM
5. Tension test on Aluminum specimen by using UTM
6. Compression test on Cast iron specimen by using UTM
7. Determine the single shear strength of mild steel by using UTM
8. Determine the Double shear strength of mild steel by using UTM
9. Determine the Brinell hardness number of mild steel, aluminum, brass specimen.
10. Rockwell hardness test on mild steel specimen by using hardness testing machine.
11. Izodtest on mild steel, copper, aluminum and brass specimen to calculate energy absorbed
12. Charpy test on mild steel, copper, aluminum and brass specimen to calculate energy absorbed
13. Conduct torsion test on mild steel bar.
14. To calculate and draw the S.F.D and B.M.D. for simply supported beam.
15. To calculate and draw the S.F.D and B.M.D. for Cantilever beam.
16. To calculate and draw the S.F.D and B.M.D. for overhanging beam.
17. To determine principal stresses and to locate principal planes for a given loading by analytical method.
18. To determine principal stresses and to locate principal planes for a given loading by graphical (Mohr's Circle) method.

**Course Outcomes:**

After learning the course the students should be able to:

**CO1** Understand the concepts of various stresses and their significant effects in context with engineering applications.

**CO2** Acquire elementary knowledge of stresses, strains & material properties. Understand & analyze the basic principles involved in the behavior of machine parts under load in the context of designing it.

**CO3** Use expressions for estimation of deformation in axially loaded members under gradual, sudden and impact loads.

**CO4** Effectively use the concepts of shear force and bending moment diagrams in design of machine elements.

**CO5** Compute the principal stresses and Strains by analytical and graphical methods (Mohr's circle of stress 2-D.

**CO6** Estimate the Slope and Deflection in determinate beams.

**CO7** Explain the important concepts of stress and strain, their significance in concept with engineering applications and is useful while studying the subjects like, Machine Design, Theory of machines, Dynamics of Machines.

**Text Books:**


1. S. Ramamrutham, Strength of Materials, DhanpatRai& Sons, New Delhi.
2. S. B. Punmia, Mechanics of Structure, Charotar Publishers, Anand.
3. B.C. Punmia, Ashok Jain, and Arun Jain, Strength of Materials, Laxmi Publications.


**Reference Books:**


1. E.P. Popov, Introduction to Mechanics of Solid, prentice- Hall, Second Edition 2005.
2. "Strength of Material" by F. L. Singer and Pytel, Harper and Row publication.
3. Timoshenko and Young, Strength of Material, East West Press, 2011.
4. A. R. Basu, "Strength of materials", Dhanapatrai& company, New Delhi.
5. I. B. Prasad," Engineering Mechanics and Strength of Materials", Khanna Publishers, 1992.


**7. Learning Websites:**

1. www.indiabix.com

2. https://www.quora.com

3. nptel.ac.in

**Course Name : Second Year Mechanical Engineering**

**Semester : Fourth**

**Subject Title : Mechanical Engineering Drawing**

**Subject Code : PCC - ME 404**

| Teaching Scheme ( in hrs ) | | | Total Credit ( TH +T+P) | Examination Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | Practical | | | Total |
| TH | T | P | CR | MSE | ESE | PR | OR | TW | |
| 2 | -- | 4 | 4 | 30 | 70 | 25# | -- | 25 | 150 |

**Course Objectives:**

The course is designed to address the following:

1. Able to apply the knowledge gained from Machine Drawing for design purpose.
2. Compare and select best suitable process for designing requirements of manufacturing Process.
3. Identify and use of particular Welding Symbol for application.
4. Student can perform CAD Software.
5. Gain skills related to actual use of Geometrical Tolerance, Machining Symbol, Welding Symbol, and Surface Roughness Symbol for an Industrial application.
6. Obtain practical skills in Assembly design.
7. Obtain practical skills in Solid modeling Related Software design.

**Syllabus:**

**Module 1: Introduction to Machine Drawing (6 Hrs)**

Dimensioning Techniques, Representation of standard components such as Screw Threads, Screw fasteners, keys, couplings, bearings, pulleys, brackets, gears, locking arrangements, Rivets and riveted joints, Welding symbols.

**Pipe Joints**: Expansion joints, stuffing box and glands, piping layouts, conventional representation of pipe fittings, valves, joints, etc.

**I S Conventions:** Need and Types, Nuts, Bolts, Gears, springs, Washers, Knurling, array of holes, Ratchet & Pawl.

**Module 2 Solid Geometry (10 Hrs)**

Intersection of surfaces and Interpenetration of Solids.

**Introduction:** Introduction, interpenetration of prism with prism, prism with cylinder, prism with cone, prism with pyramids. (Prisms and Pyramids limited up to rectangular), cylinder with cylinder, Cone with cylinder.

**Section Of Solids:** Projection of solids in simple positions or having their axes inclined to one of the reference planes and cut by a section plane inclined to one of the reference planes, true shape of section.

**Auxiliary Projection:** Projection on auxiliary vertical and horizontal plane, Auxiliary projection of simple machine components.

**Module 3: Limits, Fits & Dimensional Tolerances (4 Hrs)**

Terminology, Necessity of Limit system, Unilateral and Bilateral Tolerances, Relation between Tolerances and Manufacturing Processes, Methods of indicating tolerances on drawings, IT grades, Systems of fits, Types fits, Selection of fits, Selection of tolerances based on fits.

Surface Finish: Surface Texture, Surface Roughness Number, Roughness Symbols and Range of Roughness obtainable with different manufacturing processes.

**Module 4: Assembly and Detail Drawing (16 Hrs)**

Drawings assembled views for the part drawings of following assemblies. Importance of BOM, Preparation of BOM.

Engine parts: stuffing box, cross heads, Eccentrics, Petrol Engine connecting rod, piston assembly etc. Machine parts: Screws jacks, Machine Vices, Plummer block, Tool Post, Tailstock etc. Valves: Steam stop valve, spring loaded safety valve, feed check valve and air cock.

**Module 4: Introduction to Solid Modeling (4 Hrs)**

(To be dealt partially in practical) Types of modeling, Limitation of 2D modeling, Limitation of wire frame modeling, Need of Solid modeling, Benefits of Solid modeling.

Representation of Schemes of Solid modeling: CSG or C-rep, B- rep, Sweep, Parametric Modeling, Feature based modeling.

**Term work:**

1. Sheet on convention and machine drawing of various machine components.
2. Sheet on Solid geometry: One problem on projection solid, one problem on section of solid, one problem on auxiliary view.
3. Sheet on limit, fit, geometrical tolerance And surface finishing.
4. Sheet on assembly drawing by taking actual measurements and entering limits, fits, tolerances, surface finish symbols, geometrical requirements etc.
5. Sheet on details drawing from given assembly.
6. Sheet on assembly to details and details to assembly by using any (CAD) solid modeling software.

**Course Outcomes:**

After learning the course the students should be able to:

**CO1** Read and interpret the drawing.
**CO2** Understand the concepts of limit, fits, and tolerance for various machine parts.
**CO3** Visualize and prepare detail drawing of a given object.
**CO4** Draw details and assembly of different mechanical systems.
**CO5** Convert detailed drawing into assembly drawing using modeling software.
**CO6** Convert assembly drawing into detailed drawing using modeling software.
**CO7** Prepare detailed drawing of any given physical object/machine element with actual measurements.

**Text Books:**

1. Elementary Engineering Drawing N D Bhatt Charotar Publication House

2. Machine Drawing-By N.D. Bhatt.

3. Machine Drawing by Sidheswar, N., Kanniah, P. and Sastry, V.V.S., Tata McGraw Hill.

4. Machine Drawing by K.I. Narayana, P. Kannaiah, K.Venkata Reddy, New Edge Publication.

5. Machine Drawing by Ajeet Singh (Tata McGraw Hill)

**Reference Books:**

1. CAD CAM –Groover and Zimmer

2. Mastering CAD CAM- Ibrahim Zeid

3. R.K. Dhavan, Machine Drawing., S. Chand and Company.

4. IS Code: SP 46 – 1988, Standard Drawing Practices for Engineering Institutes.

5. Auto CAD & Autolisp Manuals by AutoDesk Corp., USA.

6. Faculty of Mechanical Engineering, “Design Data”, PSG College of Tech, Coimbatore.

7. N.D.Junnarkar Machine Drawing 1st print Pearson Education.

**Course Name : Second Year Mechanical Engineering**

**Semester : Fourth**

**Subject Title : Instrumentation & Control**

**Subject Code : PCC - ME 405**

| Teaching Scheme ( in hrs ) | | | Total Credit ( TH +T+P) | Examination Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | Practical | | | Total |
| TH | T | P | CR | MSE | ESE | PR | OR | TW | |
| 3 | -- | 2 | 4 | 30 | 70 | -- | -- | 25 | 125 |

**Course Objectives:**

The course is designed to address the following:

1. To provide a basic knowledge about measurement systems and their components
2. To learn about various sensors used for measurement of mechanical quantities
3. To learn about system stability and control
4. To integrate the measurement systems with the process for process monitoring and control.

**Syllabus:**

**Module 1: Measurement System (8 Hrs)**

• Significance of measurement, types of measurement, classification of instruments

• Static terms and characteristics- Range and Span, Accuracy and Precision, Reliability, Calibration, Hysterisis and Dead zone, Drift, Sensitivity, Threshold and Resolution, Repeatability and Reproducibility, Linearity.

• Dynamic characteristics- Speed of response, Fidelity and Dynamic errors, Overshoot.

• Measurement of error- Classification of errors, environmental errors, signal transmission errors, observation errors, operational errors.

• Transducers: Classification of transducers, active and passive, resistive, inductive, capacitive, piezo-resistive thermo resistive

**Module 2: Control systems (8 Hrs)**

• Block diagram of automatic control system, closed loop system, open loop system, feedback control system, feed forward control system, servomotor mechanism,

• Comparison of hydraulic, pneumatic, electronic control systems,

• Proportional control action, integral control action, derivative control action, PID control action.

• Applications of measurements and control for setup for boilers, air conditioners, motor speed control

**Module 3: Displacement and Temperature Measurement (8 Hrs)**

• Capacitive transducer, Potentiometer, LVDT, RVDT, Specification, selection & application of displacement transducer.

• Non-electrical methods- bimetal and liquid in glass thermometer, pressure thermometer

• Electrical methods- RTD, platinum resistance thermometer, thermistor, Thermoelectric methods - elements of thermocouple, law of intermediate temperature, law of intermediate metals, thermo emf measurement.

• Quartz thermometer,

• Pyrometers- radiation and optical

**Module 4: Flow measurements (8 Hrs)**

• Variable head flow meters-Venturi, Flow nozzle, Orifice plate, Pitot tube

• Variable area meter-Rota meter

• Variable velocity meter-Anemometer

• Special flow meter- Hot wire anemometer, Electromagnetic flow meter, Ultrasonic flow meter

**Module 5: Miscellaneous Measurement (8 Hrs)**

• Acoustics measurement- Sound characteristics –intensity, frequency, pressure, power – sound level meter, piezoelectric crystal type.

• Humidity measurement –Hair hygrometer, Sling psychrometer, Recording psychrometer

• Liquid level measurement – direct and indirect methods

**Note: Numerical on above topics**

**List of Experiments:**

1. Study contact and Non – contact type of instruments.
2. Measurement of strain by using a basic strain gauge and hence verify the stress induced.
3. Speed Measurement by using Stroboscope / Magnetic / Inductive Pick Up.
4. Calibration of LVDT transducer for displacement measurement.
5. Calibration of Bourdon's tube pressure gauge.
6. Use of Mc Leod Gauge to measure pressure.
7. Measurement of flow by using rotameter.
8. Calibration of Stroboscope.

9. Displacement measurement by inductive transducer.
10. Temperature control using Thermal Reed switch & Bimetal switch.
11. Temperature calibration by using Thermocouple.
12. Determination of negative temperature coefficient and calibration of a thermistor.
13. Measurement of force and weight by using a load cell.
14. Use of Eddy Current Dynamometer to measure force.
15. Speed of Rotating machine using Inductive Pick up.
16. Liquid Level Measurement by using Capacitive Transducer system.
17. Use Sound Meter to measure sound level of a given system.
18. Verify characteristics of photo transducer and photo diode.

**Course Outcomes:**

After learning the course the students should be able to:

**CO1** Understand concepts of process dynamics and various forms of mathematical models.
**CO2** Develop mathematical models of chemical and processes by writing unsteady-state mass and energy balances.
**CO3** Analyze, design and tune feedback / feed forward controllers in the context of various control strategies used to control chemical and biological processes.
**CO4** Recognize and fit various simple empirical models that are used for designing controllers.
**CO5** Understand and design basic control strategies.

**Text Books:**


1. “Industrial Instrumentation & Control”, S. K. Singh, Tata McGraw-Hill Education.
2. “Process Instrumentation And Control”, A. P. Kulkarni, Nirali Prakashan
3. “Process Control and Instrumentation”, R. P. Vyas, Denett & Co.


**Reference Books:**


1. "Process System Analysis & Control", Coughanower and Kappel, Mc-Graw Hill Book Company.
2. “Chemical Process Control”, George Stephanopoulos, Prentice-Hall India
3. "Industrial Instrumentation", Donald .P. Eckman, John Wiley & Sons Inc, New York.


**List of Open Source Software/learning website**:

1) NPTEL lecture series
2) Literature available on Instrumentation & Process Control
3) MIT Open course lecture on Instrumentation & Process Control

**Course Name : Second Year Mechanical Engineering**

**Semester : Fourth**

**Subject Title : Biology for Engineers**

**Subject Code : BSC - 406**

| Teaching Scheme ( in hrs ) | | | Total Credit ( TH +T+P) | Examination Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | Practical | | | Total |
| TH | T | P | CR | MSE | ESE | PR | OR | TW | |
| 2 | -- | -- | 2 | -- | -- | -- | 25@ | 25 | 50 |

**Course Objectives:**

The course is designed to address the following:

1. To understand the concept of modern biology.
2. To make the student fit for multi-disciplinary field ( engineering and biology)
3. To make students aware of application of engineering principles in biology
4. To inspire Engineers by biological aspects.

**Syllabus:**

**Module 1: Introduction (4 Hrs)**

(a) Biology & various terms used in Biology like, Botany, Zoology, Microbiology, Biomedical Sciences, Bioinformatics, Anatomy, Physiology.

(b) Body Organization, various structures & classification with function of Cell, Tissue, Organ, and System & Body.

(c) Evolution of life (Darwin's Theory) Micro-organisms & Macro organisms.

**Module 2: Sensory system (4 Hrs)**

(a) Taste, smell, Hearing, Vision, Touch.

(b) Structure & function of each sensory organ Tongue, Nose, Ear, Eyes, Skin.

(c) Reflex action.

**Module 3: Immunology (4 Hrs)**

(a) Immune system

(b) Antigen-Antibody reaction

(c) Stem cells- degeneracy in various systems.

**Module 4: Metabolism** **(4 Hrs)**

(a) Kidney: - Structure & Function

(b) Liver: - Structure & Function

(c) Heart: - Structure & Function

(d) Energy yielding & emergency consuming reactions.

**Module 5: Genetics** **(4 Hrs)**

(a) Gene: - Structure & Function

(b) Newton's law

(c) Mendel's law

(d) Concepts of segregation & independent assortment

(e) Concepts of allele

**Term work:**

Term work shall consist of assignments based on above syllabus. It should be submitted to the subject teacher to form the record of the subject.

**Course Outcomes:**

After studying the course, the student will be able to:

**CO1** Understand the body sensory system

**CO2** Understand the body Immunology

**CO3** Understand the body Metabolism Functions

**CO4** Understand the Genetics

**Reference Books:**


1. Biology: A global approach: Campbell, N.A.; Reece, J.B.: Urry, Lisa: Cain, M. L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B.: Pearson Education Ltd.
2. Anatomy and Physiology, Ross and Wilson,Churchill Livingstone.
3. Principals of Biochemistry (V Edition), By Nelson, D. L.: and Cox, M.M.W.H. Freeman and Company.
4. Molecular Genetics (second edition), Stent, G. S. and Calender, R. W. H. Freeman Company, Distributed by Satish Kumar Jain for CBS Publisher.
5. Microbiology, Prescott, L.M J.P. Harley and C.A. Klein 1995. 2nd edition Wm, C. Brown Publishers.

**Course Name : Second Year Mechanical Engineering**

**Semester : Fourth**

**Subject Title : Professional Practice, Law and Ethics**

**Subject Code : MC - 407**

| Teaching Scheme ( in hrs ) | | | Total Credit ( TH +T+P) | Examination Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | Practical | | | Total |
| TH | T | P | CR | MSE | ESE | PR | OR | TW | |
| 1 | -- | 2 | -- | -- | -- | -- | -- | 25 | 25 |

**Course Objectives:**

The course is designed to address the following:

1. To make the students understand the types of roles they are expected to play in the society as practitioners of the mechanical engineering profession
2. To develop some ideas of the legal and practical aspects of their profession.
3. To learn the principles of contract management.
4. To understand the Alternative Dispute Resolution system.
5. To understand the concept of Intellectual property.

**Syllabus:**

**Module 1 A: Professional Practice (4 Hrs)**

Respective roles of various stakeholders: Government (constituting regulatory bodies and standardization organizations, prescribing norms to ensure safety of the citizens); Standardization Bodies (ex. BIS, IRC)(formulating standards of practice); professional bodies (ex. Institution of Engineers(India), Indian Roads Congress, IIA/ COA, ECI, Local Bodies/ Planning Authorities) (certifying professionals and offering platforms for interaction); Clients/ owners (role governed by contracts); Developers (role governed by regulations such as RERA); Consultants (role governed by bodies such as CEAI); Contractors (role governed by contracts and regulatory Acts and Standards); Manufacturers/ Vendors/ Service agencies (role governed by contracts and regulatory Acts and Standards)

**Module 1 B: Professional Ethics (4 Hrs)**

Definition of Ethics, Professional Ethics, Business Ethics, Corporate Ethics, Engineering Ethics, Personal Ethics; Code of Ethics as defined in the website of Institution of Engineers (India); Profession, Professionalism, Professional Responsibility, Professional Ethics; Conflict of Interest,

Gift Vs Bribery, Environmental breaches, Negligence, Deficiencies in state-of-the-art; Vigil Mechanism, Whistle blowing, protected disclosures.

**Module 2: General Principles of Contracts Management (4 Hrs)**

*Indian Contract Act, 1972 and amendments* covering General principles of contracting; Contract Formation & Law; Privacy of contract; Various types of contract and their features; Valid & Voidable Contracts; Prime and sub-contracts; Joint Ventures & Consortium; Complex contract terminology; Tenders, Request For Proposals, Bids & Proposals; Bid Evaluation; Contract Conditions &Specifications; Critical /"Red Flag" conditions; Contract award & Notice To Proceed; Variations & Changes in Contracts; Differing site conditions; Cost escalation; Delays, Suspensions & Terminations; Time extensions & Force Majeure; Delay Analysis; Liquidated damages & Penalties; Insurance & Taxation; Performance and Excusable Non-performance; Contract documentation; Contract Notices; Wrong practices in contracting (Bid shopping, Bid fixing, Cartels); Reverse auction; Case Studies; Build-Own-Operate & variations; Public-Private Partnerships; International Commercial Terms;

**Module 3: Arbitration, Conciliation and ADR (Alternative Dispute Resolution) system: (4 Hrs)**

Arbitration – meaning, scope and types – distinction between laws of 1940 and 1996; UNCITRAL model law – Arbitration and expert determination; Extent of judicial intervention; International commercial arbitration; Arbitration agreements – essential and kinds, validity, reference and interim measures by court; Arbitration tribunal – appointment, challenge, jurisdiction of arbitral tribunal, powers, grounds of challenge, procedure and court assistance; Award including Form and content, Grounds for setting aside an award, Enforcement, Appeal and Revision; Enforcement of foreign awards – New York and Geneva Convention Awards; Distinction between conciliation, negotiation, mediation and arbitration, confidentiality, resort to judicial proceedings, costs; Dispute Resolution Boards; Lok Adalats

**Module 4: Engagement of Labour and Labour & other construction-related Laws (4 Hrs)**

Role of Labour in Civil Engineering; Methods of engaging labour- on rolls, labour sub-contract, piece rate work; Industrial Disputes Act, 1947; Collective bargaining; Industrial Employment ( Standing Orders) Act, 1946; Workmen's Compensation Act, 1923; Building & Other Construction Workers (regulation of employment and conditions of service) Act (1996) and Rules (1998); RERA Act 2017, NBC 2017

**Module 5: Law relating to Intellectual property (4 Hrs)**

Introduction – meaning of intellectual property, main forms of IP, Copyright, Trademarks, Patents and Designs, Secrets; Law relating to Copyright in India including Historical evolution of Copy Rights Act, 1957, Meaning of copyright – computer programs, Ownership of copyrights and assignment, Criteria of infringement, Piracy in Internet – Remedies and procedures in India; Law relating to Patents under Patents Act, 1970 including Concept and historical perspective of patents law in India, Patentable inventions with special reference to biotechnology products, Patent protection for computer programs, Process of obtaining patent – application, examination,

opposition and sealing of patents, Patent cooperation treaty and grounds for opposition, Rights and obligations of patentee, Duration of patents – law and policy considerations, Infringement and related remedies.

**Term work:**

Term work shall consist of assignments based on above syllabus. It should be submitted to the subject teacher to form the record of the subject.

**Course Outcomes:**

After learning the course the students should be able to:

**CO1** Illustrate as a practitioners of the mechanical engineering profession in the society.
**CO2** Develop ideas of the legal and practical aspects of their profession.
**CO3** Apply principles of contract management.
**CO4** Use alternative Dispute Resolution system.
**CO5** Perform the concept of Intellectual property.

**Reference Books:**

1. B. S. Patil, Legal Aspects of Building and Engineering Contracts, 1974.

2. The National Building Code, BIS, 2017

3. RERA Act, 2017

4. Meena Rao (2006), Fundamental concepts in Law of Contract, 3rd Edn. Professional Offset

5. Neelima Chandiramani (2000), The Law of Contract: An Outline, 2nd Edn. Avinash Publications Mumbai

6. Avtarsingh (2002), Law of Contract, Eastern Book Co.

7. Dutt (1994), Indian Contract Act, Eastern Law House

8. Anson W.R. (1979), Law of Contract, Oxford University Press

9. Kwatra G.K. (2005), The Arbitration & Conciliation of Law in India with case law on UNCITRAL Model Law on Arbitration, Indian Council of Arbitration

10. Wadhera (2004), Intellectual Property Rights, Universal Law Publishing Co.

11. T. Ramappa (2010), Intellectual Property Rights Law in India, Asia Law House

12. Bare text (2005), Right to Information Act

13. O.P. Malhotra, Law of Industrial Disputes, N.M. Tripathi Publishers

14. K.M. Desai (1946), The Industrial Employment (Standing Orders) Act

15. Rustamji R.F., Introduction to the Law of Industrial Disputes, Asia Publishing House.

**Course Name : Second Year Mechanical Engineering**

**Semester : Fourth**

**Subject Title : Management (Organization Behavior)**

**Subject Code : HSMC - 408**

| Teaching Scheme ( in hrs ) | | | Total Credit ( TH +T+P) | Examination Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | Practical | | | Total |
| TH | T | P | CR | MSE | ESE | PR | OR | TW | |
| 2 | -- | -- | -- | 15 | 35 | -- | -- | -- | 50 |

**Course Objectives:**

The course is designed to address the following:

1. To move students beyond the theories of contemporary management principles to the practice of management skills in a highly participatory classroom environment.
2. To help participants acquire practical management skills that are of immediate use in management or leadership positions.
3. To focus on defining Management Skills and clarifying their importance in the workplace.
4. To address self-awareness and the assessment of core management skills such as communication and providing effective feedback among the participants.
5. To explore more advanced Management Skills such as conflict resolution, empowerment, working with teams and creating a positive environment for change.

**Syllabus:**

**Module 1: Introduction**: **(6 Hrs)**

Managing managers, management- science, theory and practice, functions of management, evolution of management theory, contributions of Taylor, Fayol and others.

**Planning**: The nature and purpose of planning, objectives, strategies, policies and planning premises, decision making.

**Organizing**: The nature and purpose of organizing, departmenation, Line/ staff authority and decentralization, effective organizing and organizational culture.

**Module 2:** **(6 Hrs)**

**Staffing**: Human resource management and selection, orientation, apprentice training and Apprentice Act (1961), performance appraisal and career strategy, job evolution and merit rating, incentive schemes.

**Leading**: Managing human factor, motivation, leadership, morale, team building, and communication.

**Controlling:** The system and process of controlling control techniques, overall and preventive control.

**Module 3: Leadership & Motivation (6 Hrs)**

Leadership- Styles & type Motivation –Definition, Intrinsic & Extrinsic Moslow's theory of Motivation and its significance.

**Module 4: Safety Management (6 Hrs)**

Causes of Accidents Safety Procedures Introduction, Objectives & feature of Industrial Legislation such as

- Factory Act
- ESI Act,
- Workman Compensation Act,
- Industrial Dispute Act.
- Industrial Dispute Act.

**Module 5: Financial Management (No Numericals) (6 Hrs)**

Financial Management- Objectives &Functions, Capital Generation & Management, Types of capitals Sources of finance Budgets and Accounts. Types of Budgets Production Budget (including Variance Report) Labour Budget Introduction to Profit & Loss Account (Only concept) Balance sheet etc.

**Module 6 Materials Management (6 Hrs)**

Inventory Management (No Numericals) Meaning & Objectives, ABC Analysis, Economic Order Quantity: Introduction & Graphical Representation Purchase Procedure Objectives of Purchasing Functions of Purchasing Department, Steps in Purchasing.

**Course Outcomes:**

After learning the course the students should be able to:

**CO1** Understand management system and managerial effectiveness.

**CO2** Define the role of working manager.

**CO3** Record managerial activities contributing managerial effectiveness.

**CO4** Compare causes of stress in managerial life from a range covering mismatches between capabilities and role, player-manager tension and everyday stressors.

**CO5** Know time pressures and the need of time management.

**Text Books:**

1. Koontz, H. and Weirich, H., Essentials of Management, McGraw-Hill book Co., Singapore, International Edition, 5th Edition, 1990.

2. Buffa, E.S. and Sarin, R.K., Modern Production/Operations Management, John Wiley &Sons, New York, International Edition, 8th Edition, 1987.

3. Hicks, P.E., Industrial Engineering and Management: A New Perspective, McGraw-Hill Book Co., Singapore, International Edition, 2nd Edition, 1994.

**Reference Books:**

4. Riggs, J.L., Production Systems: Planning, Analysis and Control, John Wiley & Sons, New York, International Edition, 4th Edition, 1987.

5. Amrine, H.T., Ritchey, J.A., Moodie, C.L. and Kmec, J.F. Manufacturing Organization and Management, $6^{th}$ Ed., Pearson Education, 2004.

6. International Labour Organization (ILO), Introduction to Work Study, International Labour Office, Geneva, 3rd Ed., 1987.