

**Model Curriculum for**  
**B.Voc./ D.Voc.**  
**in**  
**Automotive Manufacturing**  
**Technology**



**All India Council for Technical Education**  
**Nelson Mandela Marg, New Delhi**

## 1. Introduction

All India Council for Technical Education (AICTE) Ministry of HRD, Government of India has introduced Entrepreneurship oriented Skill development courses of B.Voc. /D. Voc. /Skill Diploma. These courses will be run by AICTE approved institutes by using available infrastructure and facilities. In these courses the institute will conduct general education content and sector specific skills will be imparted by Skill Knowledge Providers/ Training Providers/ Industries.

### 1.1 Key Features:

#### Objectives

- To provide judicious mix of skills relating to a profession and appropriate content of General Education.
- To ensure that the students have adequate knowledge and skills, so that they are work ready at each exit point of the programme.
- To provide flexibility to the students by means of pre-defined entry and multiple exit points.
- To integrate NSQF within the undergraduate level of higher education to enhance employability of the students and meet industry requirements. Such student apart from meeting the needs of local and national industry are also expected to be equipped to become part of the global workforce.
- To provide vertical mobility to students admitted in such vocational courses.
- The certification levels will lead to Diploma/Advanced Diploma/B. Voc. Degree in the Automobile Manufacturing stream of Automotive Sector and will be offered by respective affiliating University/Board of Technical Education.
- Students may be awarded Level Certificate/Diploma/Advance Diploma /Degree as out-lined in the Table below:

Award	Duration after class X	Corresponding NSQF level
Level 3 Certificate	1 Year	3
Level 4 Certificate	2Years	4
Diploma	3 Year	5
Advance Diploma	4 Years	6
B.Voc. Degree	5 Years	7

## 2. Course Objectives

After successfully completing the vocational course, the student would have acquired relevant appropriate and adequate technical knowledge together with the professional skills and competencies in the field of Automobile Manufacturing so that he/she is properly equipped to take up gainful employment in this Vocation. Thus he/she should have acquired.

**A. Understanding of**

- (a) The relevant basic concepts and principles in basic science subjects (Physics, Chemistry and Mathematics) so that the students is able to understand the different vocational subjects.
- (b) The basic concepts in engineering drawing.
- (c) The concepts, principles and procedures used Automobile Manufacturing.
- (d) The knowledge of working of Automobile components.
- (e) The procedure of replacing / installing Automobile Components.
- (f) The concepts and principles used in Hybrid Automobiles.

**B. Adequate Professional Skills and Competencies in**

- (a) Providing manufacturing knowhow of two-wheeler, three-wheeler, four-wheeler and SUVs.
- (b) Testing the performance of Automobile components.
- (c) Locating the fault at component level and at the stage level.
- (d) Installing components in the Hybrid Automobiles.
- (e) Developing the devices required for mass production of Automobiles.
- (f) Preparing the production layout according to the procedures involved in manufacturing of Automobiles
- (g) Locating the fault at Automobile Manufacturing level due to improper process, scheduling etc. and its rectification.

**C. A Healthy and Professional Attitude so that the student has**

- (a) An analytical approach while working on a job.
- (b) An open mind while locating/rectifying faults.
- (c) Respect for working with their own hands.
- (d) Respect for honesty, punctuality and truthfulness

**D. NSQF compliant skills in Qualification developed by sector skill council in Automotive sector or Capital Goods Sector pertaining to Automobile Manufacturing****3. Course Structure**

The course will consist of combination of practice, theory and hands on skills in the Automotive sector and Capital Goods Sector.

**Curriculum**

The curriculum in each of the years of the programme would be a suitable mix of general education and skill development components.

**Skill Development Components:**

- The focus of skill development components shall be to equip students with appropriate knowledge, practice and attitude, to become work ready. The skill development components will be relevant to the industry as per its requirements.
- The curriculum will necessarily embed within itself, National Occupational Standards (NOSs) of specific job roles within the industry. This would enable the students to meet the learning outcomes specified in the NOSs.

- The overall design of the skill development component along with the job roles selected will be such that it leads to a comprehensive specialization in few domains.
- The curriculum will focus on work-readiness skills in each of the year of training.
- Adequate attention will be given in curriculum design to practical work, on the job training, development of student portfolios and project work.

#### General Education Component:

- The general education component adheres to the normal senior secondary and university standards. It will emphasize and offer courses which provide holistic development. However, it will not exceed 40% of the total curriculum.
- Adequate emphasis is given to language and communication skills.

The curriculum is designed in a manner that at the end of year-3, year-4 and year-5, students can meet below mentioned level descriptors for level 5, 6 and 7 of NSQF, respectively:

Level	Process required	Professional Knowledge	Professional skill	Core skill	Responsibility
Level 3	Person may carry put a job which may require limited range of activities routine and predictable	Basic facts, process and principle applied in trade of employment	Recall and demonstrate practical skill, routine and repetitive in narrow range of application	Communication written and oral with minimum required clarity, skill of basic arithmetic and algebraic principles, personal banking, basic understanding of social and natural environment	Under close supervision some responsibility for own work within defined limit
Level 4	Work in familiar, predictable, routine, situation of clear choice	Factual knowledge of field of knowledge or study	Recall and demonstrate practical skill, routine and repetitive in narrow range of application, using appropriate rule and tool, using quality concepts	Language to communicate written or oral, with required clarity, skill to basic arithmetic and algebraic principles, basic understanding of social political and natural environment	Responsibility for own work and learning

Level 5	Job that requires well developed skill, with clear choice of procedures in familiar context	Knowledge of facts, principles, processes and general concepts, in a field of work or study	A range of cognitive and practical skills required to accomplish tasks and solve problems by selecting and applying basic methods, tools materials and information	Desired mathematical skill, understanding of social, political and some skill of collecting and organizing information, communication.	Responsibility for own work and learning and some responsibility for other's works and learning
Level 6	Demands wide range of specialized technical skill, clarity of knowledge and practice in broad range of activity involving standard/ non-standard practices	Factual and theoretical knowledge in broad contexts within a field of work or study	A range of cognitive and practical skills required to generate solutions to specific problems in a field of work or study	Reasonably good in mathematical calculation, understanding of social, political and reasonably good in data collecting organizing information, and logical communication	Responsibility for own work and learning and full responsibility for other's works and learning
Level 7	Requires a command of wide ranging specialized theoretical and practical skill, involving variable routine and non-routine context	Wide ranging, factual and theoretical knowledge in broad contexts within a field of work or study	Wide range of cognitive and practical skills required to generate solutions to specific problems in a field of work or study	Good logical and mathematical skill understanding of social political and natural environment good in collecting and organizing information, communication and presentation skill	Full responsibility for output of group and development

## Curriculum

Level	Code	Educational Component	Credit	Marks
3	<b>Theory</b>			
	3.GE.01	Language – I	3	50
	3.GE.02	Applied Chemistry	3	50
	3.GE.03	Applied Physics	3	50
	3.GE.04	Applied Mathematics-I	3	50
	<b>Lab/Practical</b>			
	3.GP.01	Applied Chemistry Lab	1.5	50
	3.GP.02	Applied Physics Lab	1.5	50
	<b>On-Job-Training (OJT)/Qualification Packs</b>			
	Automotive Service Technician Level 3 (ASC/Q 1401)		(Any one)	15
Auto Body Technician Level 3 (ASC/ Q 1410)				
Casting Technician Level 3 (ASC/Q 3202)				
3	<b>Theory</b>			
	3.GV.01	General Foundation Course –I	3	50
	3.GV.02	Basic Electricity	3	50
	3.GV.03	Basic Electronics	3	50
	3.GV.04	Applied Mathematics – II	3	50
	<b>Lab/Practical</b>			
	3.VP.01	Basic Electricity – Lab	1.5	50
	3.VP.02	Basic Electronics – Lab	1.5	50
	<b>On-Job-Training (OJT)/Qualification Packs</b>			
	One more QP to be opted from the QPs mentioned in Level 3 first semester		(Any one)	15
4	<b>Theory</b>			
	4.GV.01	Engineering Science	3	50
	4.GV.02	IT Tools	3	50
	4.GV.03	Manufacturing Technology - I	3	50
	4.GE.01	Language – II	3	50
	<b>Lab/Practical</b>			
	4.VP.01	Mechanical Workshop Practice - I	1.5	50
	4.VP.02	IT Tools (Practical)	1.5	50
	<b>On-Job-Training (OJT)/Qualification Packs</b>			
	Automotive Service Technician Level 4 (ASC/Q 1402)		(Any one)	15
Auto Body Technician Level 4 (ASC/ Q 1405)				
AC Specialist (ASC/Q 1416)				
Accessory Fitter (ASC/Q 1102)				

Level	Code	Educational Component	Credit	Marks	
		Lathe Operator (ASC/Q 1901)			
4 Semester II	<b>Theory</b>				
	4.GV.04	General Foundation Course –II	3	50	
	4.GV.05	Manufacturing Technology - II	3	50	
	4.GV.06	Material Science and Material	3	50	
	4.GV.07	Motor Vehicle Technology -I	3	50	
	<b>Lab/Practical</b>				
	4.VP.03	Material Science Lab.	1.5	50	
	4.VP.04	Mechanical Workshop Practice - II	1.5	50	
	<b>On-Job-Training (OJT)/Qualification Packs</b>				
One more QP to be opted from the QPs mentioned in the Level 4 first semester		(Any one)	15	200	
5 Semester I	<b>Theory</b>				
	5.GV.01	Motor Vehicle Technology -II	3	50	
	5.GV.02	Automobile Electrical Equipment	3	50	
	5.GV.03	Two and Three Wheeler	3	50	
	5.GV.04	Modern Electric & Hybrid Vehicles	3	50	
	<b>Lab/Practical</b>				
	5.VP.01	Metrology and Measuring Instruments Lab	1.5	50	
	5.VP.02	Electric & Hybrid Vehicles Lab	1.5	50	
	<b>On-Job-Training (OJT)/Qualification Packs</b>				
	Automotive Service Technician Level 5 (ASC/Q 1403)		(Any one)	15	200
	Spare Parts Operations Executive Level 5 (ASC/Q 1502)				
Industrial Engineer (Layout Design) (ASC/Q6401)					
Tool Designer (ASC/Q4001)					
Equipment Designer L5 (ASC/Q 6405)					
5 Semester II	<b>Theory</b>				
	5.GV.05	Industrial Management	3	50	
	5.GV.06	Total Quality Management	3	50	
	5.GV.07	Entrepreneurship	3	50	
	5.GV.08	Rapid Prototyping & Reverse Engineering	3	50	
	<b>Lab/Practical</b>				
	5.VP.03	Project	3	100	
	<b>On-Job-Training (OJT)/Qualification Packs</b>				
	One more QP to be opted from the QPs mentioned in the Level 5 first semester		(Any one)	15	200
6 Semester I	<b>Theory</b>				
	6.GV.01	Automobile Electrical System	3	50	
	6.GV.02	Automobile Drawing & Design	3	50	
	6.GV.03	Automobile Engines	3	50	
	6.GV.04	Mass Production Devices	3	50	
<b>Lab/Practical</b>					

Level	Code	Educational Component	Credit	Marks	
	6.VP.01	Automobile Workshop - I	1.5	50	
	6.VP.02	Tool & Die Making Lab.	1.5	50	
	<b>On-Job-Training (OJT)/Qualification Packs</b>				
	Automotive Service Technician Level 6 (ASC/Q1404)		(Any one)	15	200
	Automation Specialist (ASC/Q6807)				
	Assembly Line Machine Setter (ASC/Q3603)				
	Process Design Engineer (ASC/Q6404)				
Quality Controller (ASC/Q1605)					
<b>6</b> <b>Semester II</b>	<b>Theory</b>				
	6.GV.05	Automobile Engine Systems	3	50	
	6.GV.06	Automotive Refrigeration and Air Conditioning	3	50	
	6.GV.07	Vehicle Performance and Testing	3	50	
	6.GV.08	Electrical & Hybrid Vehicles – II	3	50	
	<b>Lab/Practical</b>				
	6.VP.03	Automotive RAC Lab	1.5	50	
	6.VP.04	Vehicle Performance and Testing Lab	1.5	50	
	<b>On-Job-Training (OJT)/Qualification Packs</b>				
One more QP to be opted from the QPs mentioned in the Level 6 first semester		Any one)	15	200	
<b>7</b> <b>Semester I</b>	<b>Theory</b>				
	7.GV.01	Automotive System Design	3	50	
	7.GV.02	Plant Layout & Product Handling	3	50	
	7.GV.03	Industrial Engineering & Safety Engineering	3	50	
	7.GV.04	CAD & CAM	3	50	
	<b>Lab/Practical</b>				
	7.VP.01	CAD & CAM Lab.	1.5	50	
	7.VP.02	Design of Automotive Systems Lab	1.5	50	
	<b>On-Job-Training (OJT)/Qualification Packs</b>				
	Spare Parts Operations Incharge (ASC/Q1503)		(Any one)	15	200
	Body Shop In-Charge (ASC/Q1413)				
Service Supervisor (ASC/Q1412)					
Testing Manager (ASC/Q8405)					
Product Design Manager L7 (ASC/Q8103)					
<b>7</b> <b>Semester II</b>	<b>Theory</b>				
	7.GV.05	Vehicle Safety	3	50	
	7.GV.06	Agile & Lean Manufacturing Systems	3	50	
	7.GV.07	Production Planning & Control	3	50	
	<b>Lab/Practical</b>				
	7.VP.03	Project	6	150	
	<b>On-Job-Training (OJT)/Qualification Packs</b>				
One more QP to be opted from the QPs mentioned in the Level 7 first semester		(Any one)	15	200	



## **Detailed Curriculum**

### **Level 3 (Semester I)**

#### **(3.GE.01) Language - I**

#### **Module 1: Reading comprehension (prescribed texts) and functional grammar**

A variety of genres – short stories, expository pieces, biographies, poems, plays, newspaper and magazine excerpts have been included. Teaching of grammar has been integrated with the reading texts. The emphasis is on functional grammar.

The following ten prose texts and five poems have been selected for development of different reading skills.

#### **Prose texts (Prescribed)**

1. A warmer or a colder earth (popular science) Arthur – C. Clark
2. The tiger in the tunnel (narrative) – Ruskin Bond.
3. First two or four pages from Sunny Days (autobiographical) – By Sunil Gavaskar
4. Case of suspension (narrative)
5. Big brother (narrative) Shekhar Joshi
6. Father, dear father (news paper article form the Hindu)
7. Face to face (autobiographical) Ved Mehta
8. I must know the truth (narrative) Sigrun Srivastva
9. If I were you (play) Douglas James
10. India, her past and her future (speech) Jawahar Lal Nehru

#### **Poems**

1. Leisure – W H Davis
2. The road not taken – Robert Frost
3. Where the mind is without fear- Tagore
4. My grandmother's house – Kamla Das
5. The night of the scorpion – Nissi, Ezekiel

#### **Non prescribed**

In this section learners will be exposed to newspaper, articles, tables, diagrams, advertisements etc. which they have to read carefully and interpret. In the examination similar pieces will be used.

#### **Grammar and usage:**

The following points of grammar and usage have been selected from the reading passages.

1. Agreement /concord: number – gender etc.
2. Tenses: simple past (negatives/interrogatives) present perfect, past perfect continuous, past perfect, expressing future time (will and going to)
3. Passive voice (perfect tenses and modals)
4. Modals (must, should, ought to, would)
5. Linking words (to like because although, instead of, if, as, since, who, which that, when however, inspite of)
6. Reported speech, statements, questions (yes/no)

**Module 2: Functional writing and study skills**

This module help the learner to write descriptive and narrative paragraph, letters, reports notices etc. and also practice skills of note making

1. Paragraph writing
  - Describing objects
  - Describing people
  - Narrating events, stories
2. Letter writing
  - Application for leave
  - Application for jobs
  - Asking for information form various agencies (e.g. Last date for getting prospects; price of items before placing doers etc.)
3. Note making
4. Ending (punctuation, spelling, appropriate vocabulary, structures)

**(3.GE.02) Applied Chemistry****1. Structure of Atom:**

Rutherford model of the structure of atom, Bohr's theory of electrons, quantum numbers and their significance, de-Broglie equation and uncertainty principle, electronic configuration of 1 to 30 elements

**2. Periodic Properties of Elements:**

Periodic law, periodic table, periodicity in properties like atomic radii and volume, ionic radii, ionization energy and electron affinity, Division of elements into s, p, d and f blocks

**3. Chemical Bonds:**

Electrovalent, covalent and coordinate bond and their properties, Metallic bonding (electron cloud mode) and properties (like texture, conductance, luster, ductility and malleability).

**4. Fuel and their Classification:**

Definition, characteristics, classification into solid, liquid and gaseous fuel,. Petroleum and brief idea of refining into various factions and their characteristics and uses, Calorific value of fuel, Gaseous fuels- preparation, properties, composition and use of producer gas, water and oil gas.

**5. Water:**

Impurities in water, methods of their removal, hardness of water, its types, causes and removal, disadvantages of hard water in boilers, pH value and its determination by calorimetric method.

**6. Corrosion:**

Its meaning, theory of corrosion, prevention of corrosion by various methods using metallic and non-metallic coatings

**7. Plastic and Polymers:**

Plastic-thermo-plastic and thermo-setting, Introduction of Polythene. P.V.C. Nylon, synthetic rubber and phenol-formal-dehyde resin, their application in industry.

**(3.GE.03) Applied Physics**

1. **Units & Dimensions:** M.K.S. fundamentals & derived units, S.I. base units supplementary units and derived units, Dimensions of various physical quantities, uses of dimensional analysis.
2. **Surface Tension and Viscosity:** molecular forces, molecular theory of surface tension, surface energy, capillary action, concept of viscosity, coefficient of viscosity, principle and construction of viscometers.
3. **Vibrations:** Vibration as simple spring mass system, elementary and qualitative concept of free and forced vibrations, resonance. Effects of vibrations on building bridges and machines members.
4. **Heat:** Temperature and its measurement, thermoelectric, platinum resistance thermometers and pyrometers. Conduction through compound media and laws of radiations.
5. **Ultrasonics:** Productions of ultrasonic waves by magnetostriction and piezo-electric effect, application of ultrasonics in industry.
6. **Optics:** Nature of light, reflection and refraction of a wave from a plane surface. Overhead projector and Epidiascope.

**(3.GE.04) Applied Mathematics – I****Sets, Relations and Functions**

1. Sets
2. Relations and Functions-I
3. Trigonometric Functions-I
4. Trigonometric Functions-II
5. Relation between Sides and Angles of A triangle

**Sequences and Series**

1. Sequences and Series
2. Some Special Sequences

**Algebra-I**

1. Complex Numbers
2. Quadratic Equations and Linear inequalities
3. Principle of Mathematical Induction
4. Permutations and Combinations
5. Binomial Theorem

**Co-ordinate Geometry**

1. Cartesian System of Rectangular Co-ordinates
2. Straight Lines
3. Circles
4. Conic Sections

### **Statistics and Probability**

1. Measures of Dispersion
2. Random Experiments and Events
3. Probability

### **(3.GP.01) Applied Chemistry - Lab**

1. Proximate analysis of solid fuel.
2. Experiments based on Bomb Calorimeter.
3. Determination of turbidity in a given sample.
4. To determine the flash and fire point of a given lubricating oil.
5. To determine the viscosity of a given lubricating oil by Redwood viscometer.
6. To determine cloud and pour point of a given oil.

### **(3.GP.02) Applied Physics - Lab**

1. To determine the surface tension of a liquid by rise in capillary.
2. To determine the viscosity of a given liquid.
3. To determine the frequency of tuning fork using a sonometer.
4. To determine the frequency of AC main using sonometer.
5. Time period of a cantilever.

**Level 3 (Semester II)****(3.GV.01) General Foundation Course – I****A. Business Management and Entrepreneurship****(a) Entrepreneurship Orientation**

Importance and relevance in real life: Emphasis on self-employment.

**(b) Entrepreneurship Values and Attitudes**

Innovativeness, Independence, Risk Taking, Analytical ability.

**(c) Entrepreneurial Motivation**

Achievement Planning, personal efficacy, entrepreneurial goal setting.

**(d) Launching of a Business Venture**

Identification of project, steps in setting up a business, information about various institutions providing assistance, project formulation.

**B. Computational Skills**

(a) Percentage, ratio & proportion, profit & loss, discount, simple and compound interest, population growth and depreciation of value of articles using logarithm.

Area and volume: rectangle, parallelogram, circle, cube, cone, cylinder &

(b) sphere.

**C. Environmental Education**

(a) Environment and the society.

(b) Environment properties risks in different economic enterprises, in use of raw materials, in processing / manufacturing and designing.

(c) Poverty and environment.

**D. Rural Development**

(a) Agriculture, the back bone of Indian Economy.

(b) Rural development projects in India including Integrated rural development programme.

(c) Agro based rural industries.

(d) Community approach to rural development.

**(3.GV.02) Basic Electricity****1. Current Electricity**

Definition of Resistance, Voltage, Current, Power, Energy and their units, Relation between electrical, mechanical and thermal units, Temperature variation of resistance, Difference between AC and DC voltage and current

**2. D.C. Circuits**

Ohm's Law, Series – parallel resistance circuits, calculation of equivalent resistance, Kirchhoff's Laws and their applications.

**3. Electric Cells**

Primary cell, wet cell, dry cell, battery, Li-ion battery, series and parallel connections of cells, Secondary cells, Lead Acid Cell, Discharging and recharging of cells, preparation of electrolyte, care and maintenance of secondary cells.

**4. Lighting Effects of Current**

Lighting effect of electric current, filaments used in lamps, and Tube-light, LED, their working and applications.

**5. Capacitors**

Capacitor and its capacity, Concept of charging and Discharging of capacitors, Types of Capacitors and their use in circuits, Series and parallel connection of capacitors, Energy stored in a capacitor.

**6. Electromagnetic Effects**

Permanent magnets and Electromagnets, their construction and use, Polarities of an electromagnet and rules for finding them.

Faraday's Laws of Electromagnetic Induction, Dynamically induced e.m.f., its magnitude and induction, inductance and its unit. Mutually induced e.m.f., its magnitude and direction, Energy stored in an inductance.

Force acting on a current carrying conductor in magnetic field, its magnitude and direction, Principles and construction of dynamo.

**7. A.C Circuits**

Generation of A.C. voltage, its generation and wave shape. Cycle, frequency, peak value R.M.S. value, form factor, crest factor, Phase difference, power and power factor, A.C. Series Circuits with (i) resistance and inductance (ii) resistance and capacitance and (iii) resistance inductance and capacitance, Q factor of R.L.C. series circuits.

**(3.GV.03) Basic Electronics****i) Overview of Atom, Sub-Atomic Particles and CRO**

- Brief History of Electronics.
- Atom and its elements,
- Electron, Force, Field intensity, Potential, Energy, current
- Electric field, Magnetic field, Motion of charged particles in electric and magnetic field.
- Overview of CRO, Electronic and Magnetic deflection in CRO, Applications.

**ii) Voltage and Current**

- Resistance, Ohm's law, V-I Characteristics, Resistors, Capacitors, Inductors.
- Voltage and Current sources, Symbols and Graphical representation
- Overview of AC, DC, Cells and Batteries, Energy and Power.

**iii) Basics of Semiconductor**

- Semiconductor materials, Metals and Semiconductors and Photo-electric emission.
- N-type and P-type semiconductor, Effects of temperature on Conductivity of semiconductor.
- PN junction diode, depletion layer, Forward & Reverse bias, V-I Characteristic, Effects of temperature, Zener diode, Photo diode, LED, Types and applications of diode.
- Diode as a rectifier, Half wave and full wave rectification, Zener diode Regulator.
- Introduction to Filters, Clippers, Clampers

**iv) Bipolar Junction Transistor**

- Operation of NPN and PNP transistors, Biasing of BJT.

- CB, CE and CC configuration
  - Introduction to FET, JFET, MOSFET, CMOS and VMOS
- v) **Transistor Amplifier and Applications**
- Introduction, Single and Multi-stage amplifiers
  - Introduction to Oscillators
  - Introduction to Thyristors, PNP diode, SCR, LASCR, DIAC, TRIAC

### **(3.GV.04) Applied Mathematics – II**

#### **Algebra-II**

1. Matrices
2. Determinants
3. Inverse of a Matrix and its Applications

#### **Relations and Functions**

1. Relations and Functions-II
2. Inverse Trigonometric Functions

#### **Calculus**

1. Limits and Continuity
2. Differentiation
3. Differentiation of Trigonometric functions
4. Differentiation of Exponential and Logarithmic functions
5. Application of Derivatives
6. Integration
7. Definite Integrals
8. Differential Equations

#### **Vectors and Three Dimensional Geometry**

1. Introduction to Three Dimensional Geometry
2. Vectors
3. Plane
4. Straight Line

#### **Linear Programming and Mathematical Reasoning**

1. Linear Programming
2. Mathematical Reasoning

### **(3.VP.01) Basic Electricity Lab**

1. Verify that resistance of conductor is directly proportional to resistivity and length and inversely proportional to cross-sectional area of the conductor.
2. Verification of Ohm's Law.
3. Verification of temperature co-efficient of resistance:
  - (i) Positive for Tungsten and Nichrome and
  - (ii) Negative for carbon.

4. Study of series resistive circuits.
5. Study of parallel resistive circuits.
6. Study of series and parallel connection of cells in circuits.
7. Preparation of Electrolyte for lead acid battery and its charging and measurement of Specific gravity with the help of hydrometer.
8. To find heat efficiency of an electric kettle.
9. Charging and Discharging of a capacitor.
10. Verification of magnetic field of a Solenoid with:
  - (i) Iron core and
  - (ii) Air core.
11. Verification of Faraday's Laws of electromagnetic induction.
12. Verification of Torque development in a current carrying coil in magnetic field.
13. Study of R.L. series circuit and measurement of power and power factor.
14. Study of R.C. series circuit and measurement of power and power factor.
15. Study of R.L.C. series circuit and measurement of power and power factor.
16. Study of R.L.C. series circuit for calculation of inductive reactance, capacitive reactance, impedance and Q- Factor.

### **Instruments Required**

- Trainer kit for verifying ohm's law,
- Trainer kit for measuring TCR
- Lead acid battery,
- Hydrometer,
- Electric kettle,
- Trainer kit for measuring power and power factor in RLC circuits

### **(3.VP.02) Basic Electronics – Lab**

1. Study of current and voltage measurement using Ammeter and Voltmeter.
2. Study of current and voltage measurement using Galvanometer.
3. Study of current, voltage and resistance measurement using of Multi-meter
4. Study of Power and Energy measurement using Wattmeter and Energy meter.
5. Study of working principle of Signal Generator and measurement of amplitude, time period and frequency of signal using Oscilloscope.
6. Study of V-I Characteristic of Diode.
7. Study of V-I Characteristic of Zener Diode. And use of Zener Diode as voltage regulator.
8. Study of Half wave rectifier with and without filter circuit.
9. Study of Full wave rectifier with and without filter circuit.
10. Study CE configuration for NPN and PNP transistors and measurement of voltage and current gain.
11. Study CB configuration for NPN and PNP transistors and measurement of voltage and current gain.
12. Study CC configuration for NPN and PNP transistors and measurement of voltage and current gain.
13. Study of working of single layer PCB manufacturing
14. Study of working of double layer PCB manufacturing.



15. Design of 7 segment display using LED and bread board.

**Instruments Required**

- Ammeter
- Voltmeter,
- Multi-meter,
- Galvanometer,
- Energy Meter,
- CRO,
- Diode Trainer kit
- Zener diode Trainer kit
- Rectifier trainer kit
- Transistor characteristics trainer kit,
- PCB manufacturing Lab
- Bread board trainer kit to design 7 segment displays.

**Level 4 (Semester I)****(4.GV.01) Engineering Science****i) Soldering and Brazing**

General characteristics of soldering, brazing joints, processes and their characteristics, brief description of soldering and brazing tools equipment, types of solders and fluxes and their uses, soldering defects and their remedies, brazing materials, advantages and disadvantages of soldering and brazing. Introduction to PCB, PCB designing, wet etching, dry etching, track correction, wiring, single sided and double sided PCB.

**ii) Measuring Instruments**

Construction and working principles of moving iron and moving coil voltmeters and ammeters, dynamometer type wattmeter, ohm meter, megger and induction type energy meter- their circuit connection and application for measurement of electrical quantities.

**iii) Electrical Engineering Drawing**

Schematic and wiring diagram for domestic simple wiring, symbols used for different electrical devices and equipments.

**iv) Electrical wiring**

Types of wiring – cleat wiring, casing and capping, C.T.S./T.R.S. wiring, metal sheath wiring, conduit wiring and concealed wiring – their procedure. Factors of selection of a particular wiring system, importance of switch, fuse

**v) Earthing**

Earthing of wiring system, types of faults, their causes and remedies, Types of earthing- plate earthing and Pipe earthing, their procedure and application. Methods of finding numbers of circuits and circuit distribution by distribution board system loop in system of wiring connections IE rules related to wiring.

**(4.GV.02) IT Tools**

- I. Computer Organization & OS: User perspective.
  - Understanding of Hardware.
  - Basics of Operating System.
- II. Networking and Internet.
  - Network Safety concerns.
  - Network Security tools and services.
  - Cyber Security.
  - Safe practices on Social networking.
- III. Office automation tools:
  - Spreadsheet.
  - Word processing.
  - Presentation.
- IV. Multi Media Design: (Open Source Design Tools).
  - Interface and Drawing Tools in GIMP.
  - Applying Filters.

- Creating and handling multiple layers.
  - Using Stamping and Smudging tools.
  - Importing pictures.
- V. Troubleshooting: Hardware, Software and Networking.
- Commonly encountered problems.
  - (Monitor: No display, KB/Mouse not responding, monitor giving beeps, printer not responding, check for virus, Delete temporary files if system is slow, adjust mouse speed).
- Work Integrated Learning IT – ISM
- Identification of Work Areas.
  - Work Experience.

### **(4.GV.03) Manufacturing Technology -I**

#### **UNIT 1**

(A) General Introduction: (a) Scope of subject "Workshop Technology" in engineering (b) different shop activities and broad division of the shops on the basis of nature of work done such as (i) Wooden Fabrication-carpentry (ii) Metal Fabrication (shaping and Forming, Smithy, sheet metal and Joining-welding, Riveting, Fitting and Plumbing).

(B) Carpentry: (a) Fundamental of wood working operations (b) Common Carpentry Tools-Their classification, size, specification (name of the parts and use only): (i) Marking and measuring tools (ii) Holding and supporting tools: (iii) Cutting and Sawing Tools: (iv) Drilling and Boring Tools (v) Striking Tools-Mallet and Claw hammer (vi) Turning Tools & Equipment (vii) Miscellaneous Tools

#### **UNIT 2**

(A) Joining of Timber Components for Fabrications Works: Assembly of joints (Preparation steps and tools used only) Mortise, Tenon, Rivet, Groove, Tongue, Dowel, operations in assembly-simple lap and butt, Mortise, Tenon, Dovetail, Miter & bridle joints.

Metal Fabrication

(B) Metal Shaping-Smithy: (i) Operations involved (concept only) (ii) Tool and equipment used (Names, size, specification for identification only) (iii) Heating and fuel handling equipment (iv) Holding and supporting tools (v) Striking Tools (vi) Cutting tools (vii) Punching & Drifting Tools (viii) Bending Tools and figures (ix) Forming & Finishing Tools (x) Defects Occurring & its remedy

#### **UNIT 3**

Sheet metal working-Tools and operation: (1) Operations involved (Names and concept only) (2) Sheet metal joints (3) Tools and equipment used (Name, size, specifications for identification only) (4) Marking tools (5) Cutting and shearing Tools (6) Straightening tool (7) Striking Tools (8) Holding Tools (9) Supporting Tools (10) Bending tools (11) Punching-Piercing and Drafting tools (12) Burring Tools-Files (13) Defects Occurring & its remedy

#### **UNIT 4**

(A) Metal Joining During Fabrication-

(a) Permanent Joining: (i) Welding methods (ii) Electric welding

(b) Soldering & Brazing: (i) Its concept, comparison with welding as joining method and

classification (ii) Soldering operation (iii) Materials Used (iv) Defects Occurring & its remedy

(B) Riveting-

(i) Its comparison with welding as joining method. (ii) Rivets and Materials. (iii) Operation involved (iv) Tools and equipment used (Names, Size, specification and uses)), Elementary knowledge about working of pneumatic, hydraulic and electric riveter. Temporary Joining (Fasteners & their uses), General Idea about temporary fasteners & their uses

(C) Familiarity with the Use of Various Tools Used in Mechanical Engineering Workshop

(a) Marking & Measuring Tools (b) Holding Tools (c) Cutting Tools (d) Files (e) Thread Cutting Tools (h) Miscellaneous Tools

They should be shown physically to each student for familiarity.

## UNIT 5

(A) Protection of Fabricated Structures From Weather:

(a) Painting: Its need, Introduction to methods of painting (classification only) operations involved description steps only, surface preparation materials, tools and equipment used (name, size specification for identification), Brushes-round and flat wire brush, scraper, trowel, spray gun, compressor, Defects likely to occur in painting and their remedies

(b) Varnishing & Polishing: Its need, operation involved (description of steps only), surface preparation method of old and new articles, application of polishing materials, materials used for preparation of french and sprit polish, copal varnish, Defects likely to occur.

Safety of Personnel, Equipment & Tools to be observed

(B) Foundry Work:

Elementary idea of patterns, green sand moulds and moulding, tools and equipment used in green sand moulding

Suggested Reading:

Workshop Technology, Vol. I: Hazra & Chaudhry

Workshop Technology, Vol. I: BS Raghuwanshi

Karyashala Takniki: JK Kapoor

## **(4.GE.01) Language - II**

### **Module – 3: Listening and speaking skills**

In this module the learners will be exposed to a variety of listening activities recorded on audiotapes. These will be samples of good spoken English, which the learners can use as models. Work sheets will accompany the listening material.

This module will include the following:

1. Introducing yourself/friends in formal and informal situations.
2. Inviting people (over the phone and face to face) giving details of occasion, time place and date. Acceptance and refusal of invitation – formal and informal.
3. Seeking and supplying information (example opening an account in a bank, applying for loans etc.)
4. Talking and conveying messages (over the phone and face to face).
5. Giving directions / instruction.
6. Discussing contemporary issues related to environment, child labour, gender bias etc.

7. Listening to excerpts from television and radio.
8. Listening to poems/plays (prescribed).
9. Listening to speeches / talks.
10. Listening to songs like "We shall overcome".

### **Module – 4 to 6 (English for specific purposes) (opt any one)**

Three modules are being offered. A learner has to opt for any one. The first is for academic purposes and the next two are for vocational purposes. The focus is not on the teaching of the subject matter like science and literature but on the way in which language is used in the different subjects.

#### **Module 4: English for Science**

This course will introduce learners to some interesting pieces of popular science

1. Health and hygiene
2. Conservation of (nearly extinct) animals.
3. Plant life.
4. Bio gas / solar energy.

These pieces illustrate the use of English in scientific writing: giving information factually, logically and objectively.

#### **Module 5: English for Receptionist**

This module will introduce the learners to a variety of exercises, tasks and meaningful activities related to the receptionist's use of English. The printed course materials will be supported by tapes.

The following competencies be developed:

1. Receiving messages, making request etc.
2. Supplying information
3. Giving advice and making suggestions
4. Dealing with complaints
5. Making entries in an appointment book, register etc.

#### **Module 6: English for Office Use**

This course will help the learner to use English effectively and appropriately in the office environment. The competencies will be developed.

1. Using the telephone taking and passing messages.
2. Receiving messages
3. Marking noting on files and circular.
4. Writing office notes, memos, notices, agendas for meetings.
5. Telegrams and fax messages.
6. Writing business letters, application enquires, complaints.
7. Filling in forms, cheques, pay in slips etc.

### **(4.VP.01) Mechanical Workshop Practice - I**

#### **1. CARPENTRY SHOP WORK:**

- (EX-1) Planing and sawing practice
- (EX-2) Making of lap joint

(EX-3) Making of mortise and tanon joint

## **2. PAINTING AND POLISHING:**

(EX-1) To prepare a wooden surface for painting apply primer on one side and to paint the same side. To prepare french polish for wooden surface and Polish the other side.

(EX-2) To prepare metal surface for painting, apply primer and paint the same.

(EX-3) To prepare a metal surface for spray painting, first spray primer and paint the same by spray painting gun and compressor system.

The sequence of polishing will be as below- (i) Abrasive cutting by leather wheel. (ii) Polishing with hard cotton wheel and with polishing material. (iii) Buffing with cotton wheel or buff wheel.

## **3. SHEET METAL WORKING AND SOLDERING:**

(EX-1) Cutting, shearing and bending of sheet.

(EX-2) To prepare a soap case by the metal sheet

(EX-3) To make a funnel with thin sheet and to solder the seam of the same

(EX-4) To make a cylinder and to solder the same

## **4. FITTING SHOP WORK:**

(EX-1) Hack sawing and chipping of M.S. flat

(EX-2) Filing and squaring of chipped M.S. job

(EX-3) Filing on square of rectangular M.S. Plate

## **5. PLUMBING SHOP WORK:**

(EX-1) Cutting and threading practice for using socket, elbow and tee etc and to fit it on wooden practice board.

## **6. SMITHY SHOP WORK:**

(EX-1) To prepare square angular piece by M.S. rod

(EX-2) To Braze M.S. flat/Tipped tool on M.S. shank

(EX-3) To make a screw driver with metallic handle

## **7. WELDING SHOP WORK:**

(EX-1) Welding practice gas & electric

(EX-2) Welding for lap joint after preparing the edge

(EX-3) Welding Butt joint after preparing the edge

Suggested Reading:

Workshop Technology, Vol. I: Hazra & Chaudhry

### **(4.VP.02) IT Tools Lab.**

- Spreadsheets, Word, Presentation
- Multimedia Design
- Troubleshooting
- Project / Practical File
- Viva Voce

**Level 4 (Semester II)****(4.GV.04) General Foundation Course - II****A. Business Management and Entrepreneurship**

Management of Business, Elementary treatment/exposure to basic conceptual frame work of the topic listed below:

(a) Basic Function (b) Marketing Management(c) Financial Management (d) Production Management (e) Personnel Management

**B. Computational Skills**

1. (a) Solution of linear equations and their application to problem of commercial mathematics.

(b) System of linear equations and in equation in two variables. Applications in formation of simple linear programming problems

2. Statistics: Raw data, bar charts and Histogram; Frequency Tables; Frequency Polygon; Ogive; Mean, Median and Mode of ungrouped and grouped data; Standard Deviation; Introduction to Mortality tables; Price Index etc. Introduction to Computers

**C. Environmental Education & Rural Development**

Environmental Education:

- a. Modernization of agriculture and environment, irrigation, water logging, use of fertilizers, pesticides, soil erosion, land degradation (desertification and deforestation), silting and drying of water resources.
- b. Rational utilization, conservation and regeneration of environmental resources (soil, air, water, plant, energy, minerals).

**2. Rural Development**

Principles and goals of rural development, major problems/constraints in rural development in India

**(4.GV.05) Manufacturing Technology - II****UNIT 1**

GENERAL PROCESS: Classification and elementary idea of metal forming processes on the basis of the properties of deformability (Plasticity), fusibility and divisibility viz., Rolling, Forging, Drawing, Extruding, Spinning, Pressing, Punching, Blanking, Welding, Soldering, Brazing, Metal cutting processes-turning, Drilling, Boring, Shaping, Grinding, Elementary idea of machines used for the above processes.

WELDING: (a) Weld edge preparation, Introduction to various welding processes with procedure equipment and applications such as (i) Electric arc welding. (ii) Resistance welding. (iii) Thermit welding (iv) Carbon arc gauging. (v) Metal-Inert-Gas welding (MIG) (vi) Tungsten Inert Gas welding (TIG) (vii) Atomic Hydrogen arc welding. (viii) Stud welding. (ix) Laser Beam, Electron Beam welding, Explosion welding (b) Welding Arcs: Definition, arc initiation, arc structures, types of arc, metal transfer characteristics and influencing parameters, weld bead geometry, various types of electrodes used in various processes.

**UNIT2**

**WELDING OF SPECIAL MATERIALS:** (a) Welding of plastics, equipment, filler rods, weldability, procedures and precautions. (b) Welding of Grey Cast Iron, shielded metal arc gas welding procedures. (c) Welding of Aluminium, Argon arc and gas welding procedures. (d) Welding of copper, Brass and Bronze, Gas shielded metallic arc welding, TIG, Oxy-acetylene method.

**TESTING OF WELDS & RELEVANT WELDING CODES:** (a) Destructive methods (b) Non destructive methods-visual, X-ray, Y-ray, Magnetic particles, fluorescent, penetrant and ultrasonic testing.

**UNIT 3 & UNIT 4: FOUNDRY PRACTICE**

**PATTERN & MOULDING:** The pattern materials used, Types of pattern allowances and pattern layout, Colour scheme patterns defects, Types of cores and their utility.

**Moulding and Pouring:** Classification of mould materials according to characteristics, Types of sands and their importance test, parting powders and liquids, Sand mixing preparation, Moulding defects

**MELTING AND POURING:** Brief idea of refractory material and fluxes, Fuels and metallic materials used in foundry. Melting furnaces used in foundry such as pit furnace, Tilting and cupola furnaces, their construction and operation, metals and alloys. Additions to molten metal, Closing and pouring of the moulds, Coring-up, venting and closing, use of ladles, spur and risers, Defects due to closing and spurring, Basic idea of fettling operations. Surface treatment, Salvaging of castings, Factors determining soundness of casting.

**UNIT5**

**FOUNDRY PRACTICE:** Elementary idea of special casting processes-Shell mould casting, die casting, investment mould casting, centrifugal and continuous casting full mould casting. Elementary idea of mechanisation of foundries

**POWDER METALLURGY:** Introduction, principle, scope and names of processes. Production of metal powders, compaction, sintering and sizing, Self-lubricated bearings. Advantages of the process and its limitations (Elementary concept only)

Suggested Readings:

Workshop Technology, Vol. I: BS Raghuvanshi

Production Technology, Vol. I: Hazra & Chaudhry

**(4.GV.06) Material Science & Materials****UNIT 1**

**GENERAL:** Brief introduction to the subject metallurgy and its scope in engineering field, classification of materials of industrial importance. Their chemical thermal, electrical, magnetic, mechanical and technological properties and their selection criteria for use in industry

**STRUCTURE OF METALS AND THEIR DEFORMATION:**

Structure of metals and its relation to their physical, mechanical and technological properties, Elementary idea of arrangement of atoms in metals, molecular structures, crystal structures and crystal imperfections, Deformation of metals, effects of cold and hot working operations over them. Recovery re-crystallisation and grain growth, solid solutions, alloys and inter metallic compounds, effect of grain size on properties of metals.

**PROPERTIES AND USAGE OF:** (1) Metals: (a) Ferrous Metals (b) Non Ferrous Metals (2) Non-metallic Materials.

**UNIT 2: METALS-FERROUS METALS**

(a) Classification of iron and steel. (b) Cast iron types as per I.S. - White, malleable, Grey (c)



Steels: Classification of steels according to carbon content and according to use as per I.S. Mechanical properties of various steels and their uses. Availability of steel in market, Its forms and specifications (d) Alloy Steel: Effect of alloying various elements, viz Cr, Ni, Co, V, W, Mo, Si, and Mn, on mechanical properties of steel, Common alloy steels, viz, Ni-steel, Ni-Cr-steel, Tungsten steel, Cobalt steel, Stainless Steel, Tool steel - High Carbon Steel, High Speed steel, Tungsten Carbide, Silicon manganese steel, Spring Steel, Heat Resisting alloy Steels etc.

### **UNIT 3: NON-METALIC MATERIALS**

(a) Plastic and Other Synthetic Materials: Plastics- Important sources-Natural and Synthetic, Classification, thermo-set and thermoplastic, Various trade names, Important Properties and engineering use of plastics. Market forms of Plastics

(b) Paints, Enamels, Varnishes and Lacquers: Paints and Enamels-types, its purpose, essential ingredients and their role, characteristics of a good paints and enamel, trade names of some important types of products. Varnishes-types purpose of varnish, essential ingredients and their role, characteristics, preparation, trade names storage of varnish, Lacquer- characteristics, preparation and uses

### **UNIT 4: NON-METALIC MATERIALS**

(c) Heat Insulating Materials: Classification of Heat Insulating material, properties and uses of China clay, Cork, Slag wool, Glass Wool, Thermocole, Puff, Properties and uses of asbestos as filler material.

(d) Hardware: General specification, uses and methods of storage of G.I. and C.I. steel, Copper, A.C. pressure conduits, R.C.C. spun, P.V.C. Pipes and their uses. General sheets specification (I.S.) and uses, Method of storage of G.I. sheets, M.S. sheets, General specification of pipe fitting

### **UNIT 5**

IDENTIFICATION AND TESTING OF METAL ALLOYS: Selection, specification forms and availability of materials.

HEAT TREATMENT OF METALS: Elementary concept, purpose, Iron-carbon equilibrium diagram. T.T.T. and 'S' curve in steels and its significance, Hardening, Tempering, Annealing, Normalising and case hardening

Suggested Reading:

MATERIAL SCIENCE: RS Khurmi & RS Shedha

## **(4.GV.07) Motor Vehicle Technology - I**

### **UNIT1: INTRODUCTION & CHASSIS LAYOUT**

General study of the motor vehicle with functions of its main components and assemblies (engine excluded), Development of a Tractor and its basic function and H.P. requirements, Conventional layout of chassis Front wheel drive, four wheel drive, rear engine vehicle, their advantages and disadvantages, Layout of Maruti car chassis and tractor chassis, Definitions of items-wheel track, wheel base, front and rear overhang, kerb weight, ground clearance.

### **UNIT2: CLUTCH SYSTEM**

Layout of conventional transmission system, Maruti car transmission system, Tractor transmission system, clutch - necessity, functions, requirements, types, Constructional details and working of single plate, multiple plate, diaphragm clutches, fluid coupling, Centrifugal and semi-centrifugal clutch, Tractor clutch, Clutch pedal free play. Torque

transmitted by clutch. Simple numerical problems. Clutch defects, probable causes, remedies.

### **UNIT3: GEAR BOX**

Function and necessity, Construction and working details of sliding mesh, constant mesh, synchromesh gear boxes; epicyclic gear box - its applications and advantages. Over drive, Torque convertor, Maruti-800 car gear box, tractor gear box and P.T.O. shaft, 4 wheel drive auxiliary gear box. Gear ratio

### **UNIT4: FINAL DRIVE**

Torque tube drive, Hotchkiss drive, Universal joints, constant velocity joints, slip joints, Propeller shaft. Differential, slip differential, double reduction differential, final drive ratio. Tractor final drive construction and working, Rear axles-Fully floating, semi-floating, three quarter floating, Tractor axles

### **UNIT5: WHEELS AND TYRES**

Road-wheels - Rim types and sizes, Tyres-conventional, radial, Tubeless tyre its advantages, Tyre sizes, wheels-front and rear, Tyre retreading, Tyre wear, wheel balancing, Tyre pressure, Advantages of filling nitrogen in tyres.

#### **(4.VP.03) Material Science Lab.**

1. (a) Study of various crystals structures through models BCC, FCC, HCP, tetrahedral and octahedral voids.  
(b) Material identification of, say, 50 common items kept in a box.
2. Specimen preparation for metallographic examination /micro structural examination-cutting, grinding, polishing, etching.
3. Comparative study of microstructures of different given specimens (mild steel, gray C.I., brass, copper etc.)
4. Heat treatment experiments such as annealing, normalizing, quenching, case hardening and comparison of hardness before and after.
5. Study of Microstructure and hardness of steel at different rates of cooling, Microstructure examination of white cast iron.

#### **(4.VP.04) Mechanical Workshop Practice - II**

##### **1. Welding Shop Work**

- Exp-1: Welding practice-gas and electric
- Exp-2: Welding for lap joint after preparing the edge
- Exp-3: Welding for Butt joint after preparation of the edge
- Exp-4: 'T' joint welding after preparation of edge.

##### **2. Carpentry**

- (i) Bridle joint (ii) Dovetail joint (iii) Utility article like picture frame, larger peg, Name plate etc.
- 3. Fitting
  - (i) Drill a hole in MS Block & tapping the same (ii) Making a Bolt & Nut by Tap & Die set. (iii) Utility article-screw driver, Paper weight.
- 4. Smithy

(i) To make square or hexagonal head bolt (ii) To make ring with hook (iii) Utility article-to prepare a fan hook.

5. Tin Smithy, Soldering, Brazing

(i) To prepare different types of joint such as lap joint single seam, double seam & cap joint-hem & wired edge. (ii) Utility article-waste paper basket or paper tray (iii) Study & sketch stakes/ anvils.

Suggested Reading:

Elements of Workshop Technology Vol. I: BS Raghuwanshi

## **(5.GV.01) Motor Vehicle Technology - II**

### **UNIT 1: FRAME AND BODY**

Function and construction of frame. Cross-section of frames. Unitized construction (monocoque) types of bodies. Terms - Turning radius, lock-to-lock angle, centre point steering, positive steering, gradeability. Idea of Safety features in a modern car.

### **UNIT 2: SUSPENSION SYSTEM**

Function. Types - conventional and independent. Spring types - coil, leaf - elliptical, semi-elliptical; helper springs, transverse springs. Spring camber; spring material. Torsion bar, stabiliser bar. Shock absorbers- telescopic and gas. Maruti suspension system and shockers. Anti-roll bars. Nitrox suspension.

### **UNIT 3: STEERING SYSTEM AND FRONT AXLE**

Principle - Ackermann and Davis. Function, requirements. Steering gear box - types. Construction and working details of worm and sector, rack and pinion, worm and wheel, worm and recirculating ball type. Tractor steering. Power steering. Electronic Steering. Front axle - rigid front axle. Stub axle. Elliot and reverse Elliot type. Lemoine and reverse lemoine type. Tractor front axle. Maruti steering system.

Wheel alignment - castor angle, camber angle, K.P.I., Toe-in, toe out. General values of these.

### **UNIT 4: BRAKING SYSTEM**

Braking terms - braking efficiency, stopping distance, stopping time, weight transfer during braking, leading/trailing shoe of brake. Determination of braking torque. Effect of braking on steering. Types of braking systems- constructional details and working of mechanical brakes, hydraulic brakes, parking brake, vacuum, pneumatic, air-hydraulic brakes; tractor brakes. Drum and disc brakes. Master cylinder, tandem master cylinder, wheel cylinder. Brake lining and brake fluid. Brake defects, their causes and remedies. Anti-Lock Braking System (ABS) & Electronic Brake Distribution (EBD).

### **UNIT 5: AUTOMOBILE POLLUTION AND ITS CONTROL**

Effects and extent of pollution caused due to stationary and automobile engines. Harmful products and their causes in petrol & diesel engines. Measures to control exhaust emissions from two-stroke engines, four-stroke engines, and diesel engines. Turbocharger. Products which cause de-activation of catalysts in catalytic converters. Unleaded petrol. Emission measuring instruments for petrol and diesel engines. Limits specified in Motor Vehicles Act. Recent trends in Automobile Pollution Control-Exhaust Gas Recirculation. Air Injection, Reactor System. Positive Crankcase Ventilation. Evaporative Emission Control System.

**(5.GV.02) Automobile Electrical Equipment****Unit 1: Automobile Wiring Systems & Cables**

Earth-return and insulated-return systems; 6 Volt, 12 Volt and 24 Volt systems. Positive and negative earthing. Cables-starting systems cables, general purpose cables and high-tension cables; specifications and colour codes. Diagram of a typical wiring system. Wiring harness, cable connectors, circuit breakers, plastic fibre-optic wires, printed circuits. Fuses in circuits.

**Unit 2: Storage Battery**

Principle of lead-acid cells; constructional details of battery plates, separator, container, terminal, vent plug, grouping compound. Electrolyte: specific gravity of electrolyte and its variation with temperature. Effect of charging and discharging of specific gravity. Capacity of battery. Efficiency of battery. Methods of charging of battery. Internal circuit of battery charger. Care and maintenance of batteries. Checking for cell voltage and specific gravity of electrolyte. Battery tests- high discharge test, cranking motor test, open-circuit voltage test, cadmium test, life test. Battery failures, Maintenance-free batteries, VRLA batteries, Traction battery. Alkaline type batteries. Fuel cell and its types, Battery Life enhancer.

**UNIT 3: Dynamo**

Principle of generation of D.C. Constructional details of a Dynamo. Armature reaction. Principle of commutation. Construction of commutator. Types of wound field generator-series, shunt and compound wound. Other types of D.C. generators-four brush & four pole, interpole, split field and bucking field. Dyna-Starter, Generator drive.

**UNIT 4: Alternator**

Principle of generation of A.C. Constructional details of an alternator. Working of alternators. Advantages over dynamo. Types of alternators. Charging of battery with an alternator. Regulator for alternators.

**UNIT 5: Regulators**

Constant current and constant voltage systems, Double-contact and compensated voltage-control regulators. Current-and-voltage regulator, Cut-out

Suggested Reading:

Automotive Electrical Equipment: PL Kohli

Modern Electrical Equipment: AW Judge

Automotive Electrical Equipment: WH Crouse

**(5.GV.03) Two and Three Wheeler****Unit I: The Power Unit**

Two stroke and four stroke SI & CI engine Construction and Working, merits and demerits, Symmetrical and unsymmetrical valve & port timing diagrams, scavenging process

**Unit II: Fuel and Ignition Systems**

Fuel system – Different circuits in two wheeler fuel systems, fuel injection system. Lubrication system, Ignition systems - Magneto coil and battery coil spark ignition system, Electronic ignition System, Starting system - Kick starter system – Self-starter system, Recent technologies

**Unit III: Chassis and Sub-Systems**

Main frame for two and three wheelers, its types, Chassis and different drive systems for two wheelers, Single, multiple plates and centrifugal clutches, Gear box and its and various gear controls in two wheelers. Front and rear suspension systems, Shock absorbers, Panel meters and controls on handle bar, Freewheeling devices

**Unit IV: Brakes and Wheels**

Drum brakes & Disc brakes Construction and Working and its Types, Front and Rear brake links layouts.

Brake actuation mechanism. Spoked wheel, cast wheel, Disc wheel & its merits and demerits.

Tyres and tubes Construction & its Types. Steering geometry

**Unit V: Two & Three Wheelers - Case Study**

Case study of Sports bike, Motor cycles, Scooters and Mopeds - Auto rickshaws, Pick up van, Delivery van and Trailer, Servicing and maintenance, recent developments

**(5.GV.04) Modern Electric and Hybrid Vehicles****Unit 1: Introduction**

Introduction to electric and hybrid electric vehicles, History of hybrid and electric vehicles, Social and environmental importance of electric and hybrid electric vehicles, Electrical basics, Motor and generator basics

**Unit 2: Electric and Hybrid Electric Drive Trains**

Basic concept of electric and hybrid traction, Introduction to various electric and hybrid electric drive train topologies, Advantages and disadvantages

**Unit 3: Power Flow**

Power flow control in electric and hybrid electric drive train topologies.

**Unit 4: Electric Drive Components**

Introduction to electric drive components used in electric and hybrid vehicles, Electric motor requirements, Direct Current (DC) motors (Brushed and Brushless), Power converters, Drive controllers.

**Unit 5: Regenerative Braking System (RBS)**

Introduction and need of Regenerative Braking System, Advantages and disadvantages of RBS, Working of RBS, Concept of Regenerative Braking using Piezoelectric material, Using shock absorbers as vibration energy harvesters.

Suggested Reading:

Automotive Fuel Technology-Electric, Hybrid and Fuel-Cell Vehicles: Jack Erjavec & Jeff Arias

Electric and Hybrid Vehicles: Design Fundamentals: Iqbal Husain

Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory and Design: Mehrdadsani, Yimingao, Ali Emadi

**(5.VP.01) Metrology and Measuring Instruments lab.**

1. Measurement of angle with the help of sine bar/ Vernier Bevel protractor.
2. Study and sketch of various types of optical projectors.
3. Study and sketch of various types of comparators and use them for comparing length of given piece.
4. To measure the diameter of a hole with the help of precision balls.
5. To measure external and internal taper with the help of taper gauges, precision rollers.
6. To test the squareness of a component with auto-collimeter.
7. To measure the pitch, angle and form of thread of a screw.
8. To measure the geometry of a gear having involute profile.
9. To measure the straightness of the edge of a component with the help of auto-collimeter.
10. To measure the length, breadth, thickness, depth, height with micrometer.
11. To measure the length, breadth, thickness, depth, height, with height gauge and Vernier calipers.
12. Calibration of Vernier calipers/micrometers.
13. Calibration of height gauge/depth gauge.
14. Study of a tool maker's microscope.
15. Checking of accuracy of snap gauge with slop gauge.
16. Checking of accuracy of a plug gauge with micrometer.
17. Measurement of areas by polar planimeter.
18. Use of feeler, wire, radius and fillet gauges measurement of standard parameters.

**(5.VP.02) Electric and Hybrid Vehicles Lab**

1. Understand working of different configurations of electric vehicles
2. Understand hybrid vehicle configuration and its components, performance analysis
3. Understand the properties of batteries and its types
4. Understand of electric vehicle drive systems.
5. Understand of hybrid electric vehicles.
6. Understand Auxiliary systems including charging, starter motor, on board power supply, lighting and environmental sensing and conducting repairs. Repair & Replacement of Electric/ Hybrid Vehicle body
7. Repair & Replacement of Electric Vehicle Drive Train
8. Fault diagnosis & repair / replacement of Battery, DC & AC Electrical Machines, Hybrid Electric Vehicles

**Level 5 (Semester II)****(5.GV.05) Industrial Management****1. Introduction:**

Growth of industry, The management of men, materials and machines, the art of management, Sources of capital- industrial individual enterprise, private partnership and private Ltd. Co., Joint Stock Co. shares, debentures, financial agencies and their role in promoting industries. Break even analysis.

**2. Private sector and public sector:**

Public sector enterprise, merits and demerits of public sector industry and private sector industry, Line, staff and functional organizations, reasons for the choice of various types of organization, functions of different departments, viz. stores, purchase and sales departments relationship between individual departments.

**3. Wages & incentives:**

Definition of wages, real wage and nominal wage, systems of wage payment, incentives, financial and non - financial incentives, Essentials of a good wage plan, essentials of a good incentive scheme. Introduction to elements of cost & indirect expenses, Material cost, labour cost, fixed and variable overheads, components of cost, selling price, Factory expenses, administrative expenses, selling & distribution expenses, depreciation, obsolescence, interest on capital, Idleness, Repair and maintenance.

**4. Labour, industrial & tax laws:**

Evolution of industrial law, factory act, workmen compensation act, payment of wages act, employee's state insurance act, Industrial dispute act. Role of technician in industry: Position of technician in various engineering departments, Role of a supervisor in industry, Foremanship, duties and qualities of a good foreman.

**5. Material management:**

Introduction, Scope of Material Management selective control techniques-ABC analysis, Material handling, inventory control, Essential steps in inventory control, quality standards

**(5.GV.06) Total Quality Management****1. Introduction, Basic concepts of total quality management**

Introduction to Quality, Dimensions of Quality, Quality Planning, Concept and definition of quality cost, Determinants of Quality, Optimum cost of performance, Principles of TQM, Pillars of TQM, Introduction to leadership and Leadership roles, Quality council and Quality statement, Strategic Planning Process, Deming philosophy

**2. Continuous process improvement**

Input /output process Model, Juran trilogy, PDCA Cycle, 5-'S' Housekeeping principle, Kaizen Seven tools of Quality (Q-7 tools), Check Sheet, Histogram, Cause and effect diagram, Pereto diagram, Stratification analysis, Scatter diagram, Control charts, Control chart for variables & process capability, Control chart for attributes

**3. Management planning tools & Bench marking**

Affinity diagram, Relationship diagram, Tree diagram, Matrix diagram, Matrix data analysis,

Arrow Diagram, Process decision programme chart (PDPC), Concept of bench marking, Reason to bench marking, Bench marking process, Types of bench marking, Benefits of bench marking

#### **4. Just in time (JIT)**

JIT philosophy, Three elements of JIT, Principles of JIT Manufacturing, JIT Manufacturing building blocks, JIT benefits, Kanban & 2 Bin Systems

#### **5. Total productive maintenance (TPM)**

Concept of Total Productive Maintenance, Types of maintenance, OEE (Overall Equipment Efficiency), Stages in TPM implementation, Pillars of TPM, Difficulties faced in TPM implementation.

### **(5.GV.07) Entrepreneurship**

#### **1. Entrepreneurship and entrepreneur:**

Need of Employment and Opportunities, Essential Characteristics of a good Entrepreneur, Industrial Policy, Classification of industries- Micro, small scale , Medium scale, Large scale, Type of industries- Production, Job based & Service

#### **2. Entrepreneurial Development:**

Product identification/ selection, Site selection, Plant layout, Institutional support needed, Pre-market survey.

#### **3. Entrepreneurship Support System and Start-ups:**

Introduction to start-up's, Role of District Industries Centre in setting up industry, Function of NSIC, SISI, NISIET, NRDC, SSIC, SIDO, NMTC, KVIC, RSMML, Role of state finance corporation, state electricity corporations, pollution control board, BIS, I.S.O. etc.

#### **4. Introduction to Tax System, Insurance and Acts:**

Idea of income tax, sales tax, excise duty and custom duty, Industrial and fire insurance, procedure for industrial insurance, Introduction to Industrial acts, factory act, Workmen's compensation act 1923, Apprentices act 1961, Environmental protection act 1986

#### **5. Project Report Preparation:**

Procedure of preparing a project report, Format of project report, Preparation of project report, Introduction to ISO: 9000 Series of Quality System

### **(5.GV.08) Rapid Prototyping & Reverse Engineering**

#### **1. Introduction:**

Introduction to Prototyping, Traditional Prototyping Vs. Rapid Prototyping (RP), Need for time compression in product development, Usage of RP parts, Generic RP process, Distinction between RP and CNC, other related technologies, Classification of RP.

#### **2. CAD Modelling and Data Processing for RP:**

CAD model preparation, Data Requirements, different types of Data formats, Data interfacing, Part orientation and support generation, Support structure design, Model Slicing and contour data organization, direct and adaptive slicing, Tool path generation.

#### **3. RP Systems:**



Photo-polymerization process, Powder Bed Fusion process, Applications of Powder Bed Fusion Processes. Extrusion - Based RP Systems, 3D Printing process modelling, Applications of Printing Processes. Sheet Lamination process /Laminated Object Manufacturing (LOM), Beam Deposition: Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Processing - structure- properties, relationships, Benefits and drawbacks.

#### **4. Rapid Tooling:**

Conventional Tooling Vs. Rapid Tooling, Classification of Rapid Tooling, Direct and Indirect Tooling Methods, Soft and Hard Tooling methods.

#### **5. RP Applications:**

Design, Engineering Analysis and planning applications, Rapid Tooling, Reverse Engineering, Medical Applications of RP

### **(5.VP.03) Project**

On the basis of learning in the vocational diploma, a project to be taken up by the student strengthening his/ her vocational skills

**Level 6 (Semester I)****(6.GV.01) Automobile Electrical System****UNIT 1: STARTING SYSTEM**

Principle, construction and working of starter motor. Series motor and its characteristics, Compound wound motor, Engine starting circuit, Starter drives-Bendix (torsion, compression), over-running clutch and sliding armature types. Starter switch - manual, solenoid, Factors affecting the starting of engines, Torque terms. Starting torque and power required, Motor efficiency, Armature reaction, Typical motor specifications

**UNIT 2: IGNITION SYSTEM OF SPARK-IGNITED ENGINES**

Types of ignition systems- battery-and-coil, magneto ignition systems. Ignition circuit. Details of the ignition system-ignition coil, distributor, condenser, contact breaker points, rotor, distributor cap, distributor drive. Firing order. Ignition timing. Ignition advance and retard, need, and factors it depends upon. Methods for obtaining advance and retard-vacuum and mechanical. Optical sensor for spark timing.

**UNIT 3**

Spark plugs-constructional details; types used in automobiles, conditions of working of spark plugs. Glow plugs of diesel engines. Magneto-rotating armature and rotating magnet types. Electronic ignition of cars & motor-cycles (CDI), Idea of Distributor-less Direct ignition system.

**UNIT 4: LIGHTING SYSTEM**

Requirements of automobile lighting. Head lamp - mounting and construction; Plastic headlamp Lens, sealed beam assembly. Asymmetrical head light, dipper and full beam, care of headlamp, Lens cleaners. Dynamic headlight beam control, Advanced Front lighting system (AFS) Types of bulbs. Reflector optics. Light sources – tungsten light Sources, tungsten halogen light sources, halogen infra-red reflective light sources, HID light sources (Xenon and bi-xenon), LED light sources, Blue vision head lamp. Auxillary lights, Brake light, Fog light, Flasher unit, warning lights and panel lights.

**UNIT 5: ACCESSORIES**

Fuel and oil pressure gauge, cooling water temperature gauge, electrical speedometer, amperemeter, wind-screen wiper, electrical horn and relay, cigarette lighter, Odometer, wind-shield washing equipment, engine rpm meter, glow plug indicator, cluster assembly. Radio and television Interference suppressors, electrical switches. Central locking of doors, power winding of window panes, car heaters AC, blower and air flow controls, Rear defogger.

Suggested Reading:

Automotive Electrical Equipment: PL Kohli

Modern Electrical Equipment: AW Judge

Automotive Electrical Equipment: WH Crouse

**(6.GV.02) Automobile Drawing & Design****Unit 1**

Drafting of sectional views of the following assemblies: (a) Cylinder block and crankcase of

2-wheeler, (b) Poppet valve assembly of a 4-stroke engine, (c) Piston assembly, (d) Connecting rod assembly, (e) Spark plug, (f) Injector.

### **Unit 2**

Free hand line diagram of the following systems: (a) Fuel system of petrol engine (b) Fuel system of diesel engine (c) Cooling system of a multi-cylinder engine (d) Lubricating system of a multi-cylinder engine (e) Steering system of Maruti (f) Suspension systems of Maruti (g) Hydraulic Braking System of Maruti Zen (h) Air Hydraulic Braking System of TATA (i) Block diagram of Electronic Fuel Injection (EFI) system (j) Block diagram of Common Rail Direct Injection (CRDI) system (k) Oxygen sensor (l) Fuel injector of EFI.

### **Unit 3**

Drafting of sectional views of the following assemblies

(1) Master cylinder (2) Wheel cylinder (3) Universal joint

### **Unit 4**

Sketch layouts of (a) Depot (b) F.I. pump reconditioning shop (c) Electrical Workshop.

### **Unit 5**

Design of the following components of an automobile engine

(1) Piston assembly (2) Connecting rod assembly (3) Crank shaft (4) Flywheel

Suggested Readings:

Automobile Drawing: RB Gupta

## **(6.GV.03) Automobile Engines**

### **UNIT 1**

(A) Fundamentals of Thermodynamics: Internal energy, Enthalpy, Mechanical Equivalent of Heat, Conservation of energy. First and Second Law of thermodynamics. P-V diagram. Reversible process. Various thermodynamic processes. Entropy, General case for change of entropy of a gas. Change of entropy during various processes. Temperature-entropy diagram. Simple numerical problem

(B) Air standard cycles: Otto cycle, Diesel cycle, Air standard efficiency of Otto and Diesel cycle. Effect of compression ratio on efficiency. Simple numerical problems. Graphical representation of ideal and actual cycle. Comparison between actual and ideal cycles. Reasons for variation. Mean effective pressure. Work done during the cycle.

### **UNIT2**

(A) I.C. Engines' operation: Working of two stroke cycle and four stroke cycle petrol and diesel engines. Valve timing diagrams. Port timing diagrams. Classification of I.C. Engines.

(B) Reciprocating Engine Details: Construction, function, material and manufacturing process of: (a) Cylinder Block- 2-stroke air cooled and 4-stroke water cooled cylinder liner (wet and dry), cylinder head, gaskets. Different cylinder arrangements. Cylinder wear. Forms of combustion chamber in petrol engine. Location of spark plug. Combustion chamber in Diesel engines. Turbulence in Combustion chambers.

### **UNIT3: Engines Details (continued)**

(b) Piston-plain, split skirt, auto-thermic, cam-ground, Anodising and Tinning of piston, Piston clearance (c) Piston rings-different types (d) Piston pin; different methods of fitting piston pin (e) Valves: Poppet, Rotary, reed, Poppet Valve arrangement, Overhead and side

valve operating mechanism. Valve clearance. Hydraulic tappet. Sodium cooled valves. Valve seat inserts (f) Connecting rod, Section of connecting rod. Bearing metal for big and small end of connecting rod (g) Crank shaft. Left hand, right hand crankshaft. Balancing of crank shaft (General idea about static and dynamic balancing, problems excluding). Main bearings. Crankshaft end play. Vibration damper. Flywheel (h) Camshaft, Camshaft drive timing gears (i) Inlet and exhaust manifold, Mufflers, Exhaust pipe (j) Variable Valve Timing (VVT).

#### **UNIT4**

(A) Rotary Engine. Principle and operation. Engine cooling. Advantages and limitations.

(B) Internal combustion Turbines. Principle of working, Classification, Brayton cycle. Cycle efficiency. Friction effect. Optimum compression ratio. Simple numerical problems, Deviation of practical cycles. Methods to improve efficiency, Turbine characteristics, combustion chamber, Fuel injection, Ignition Gas turbine Fuels, Materials. Turbine blades.

#### **UNIT5**

(A) Supercharging and scavenging. Necessity of supercharging, Rotary compressors, Turbocharger requirement, Effect of supercharging on power output, mechanical losses, fuel consumption, detonation, Limitations of supercharging. Methods and classification of scavenging process. Performance of different scavenging systems.

(B) Engine specifications, specifications of engines of Indian vehicles - four wheelers, three wheelers and two wheelers.

Suggested Readings:

Thermal Engineering I & II: Sarao, Gambhir & Aggarwal

Automobile Engineering II: Kirpal Singh

Basic Automobile Engineering: CP Nakra

Automobile Engineering: RB Gupta

### **(6.GV.04) Mass Production Devices**

#### **1. Tool holders:**

Tool holders for turning and milling carbide inserts-types, ISO-designation and applications, Tool holding and tool mounting systems for conventional milling and drilling machine tools.

#### **2. Locating and clamping devices:**

Concept, meaning and definitions of location and clamping, Use of locating and clamping principles in day-to-day supervision on shop floor, Degree of freedom-concept and importance, 3-2-1 principle of location, Locators-Types, Sketches with nomenclature, Working, Applications, Fool proofing and ejecting

#### **3. Clamping devices:**

Types, Sketches with nomenclature, Working, Applications

#### **4. Jigs and fixtures:**

Concept, meaning, differences and benefits of jigs and fixtures, Types, sketches with nomenclature, working and applications of jigs, Types, sketches with nomenclature, working and applications of fixtures,

#### **5. Design of Jigs and Fixtures:**

Steps in designing jigs and fixture for given simple component

**(6.VP.01) Automobile Workshop - I****UNIT 1**

Engine tuning: Meaning and scope of engine tuning. Necessity of engine tuning, Service data of Maruti: Alto, WagonR, Swift (Petrol & Diesel); Hyundai: Santro, Ford: Figo; Volkswagen: Polo; Chevrolet: Spark. Engine analysis and tuning with the help of diagnostic computer, Diesel engine injection timing checking

**UNIT 2**

Wheel Balance: Reasons of wheel imbalance, Effect of wheel imbalance on stability of vehicle. Static and dynamic balancing, Wheel balancing by the application of weights, Wheel Alignment: Meaning of wheel alignment, Various angles-camber, caster, KPI & toe - and their effect on steering stability, General values of popular Indian vehicles, Wheel alignment on computerised wheel aligner

**UNIT 3**

Measurement of Exhaust Pollution by various analysers such as Four Gas Analyser, Smoke meter, Nox analyser

**UNIT 4**

Use of Headlight aligner, Wheel aligner, automotive oscilloscope

**UNIT 5**

Servicing: Meaning and scope of servicing, Items attended to in servicing of a vehicle. Servicing a vehicle, Focussing and alignment of head lights

Suggested Reading:

Engine Service: Gary Lewis

Various Car's Manuals

**(6.VP.02) Tool & Die Making Lab.**

1. Manufacture of Box Jig and Angle plate jig
2. Manufacture of "V" Block angle grinding Fixtures and profile milling fixture
3. Manufacture of simple Blanking & piercing Tool
4. Manufacture of Progressive tool for producing a Cycle chain link
5. Manufacture of Press tools like Combination tool & Compound tool
6. Manufacture of Draw tool
7. Trial out On Fly press and power press the Produced components such as V, U, Cycle link, Cup, Washer and Cycle bell cup
8. Manufacture of simple V and U bending tool
9. Maintenance of Jig & fixture and press tool

**Level 6 (Semester II)****(6.GV.05) Automobile Engine Systems****UNIT 1**

**STARTING SYSTEM:** Idea of engine starting-system circuit. Kick-starting system of 2 wheelers. Starting of mopeds.

**IGNITION SYSTEM:** Idea of Battery-and-coil ignition circuit and its working. Compression ignition of diesel engines.

**LUBRICATION SYSTEM:** Lubrication in 2 stroke engines - petrol and oil-injection. Lubrication in 4 stroke multi-cylinder petrol/diesel engines. Dry and wet sump lubrication. Full pressure and semi-pressure lubrication. Oil pump types. Oil pump drive, relief valve; pressure gauge. Oil filters. Full-flow and by-pass type filtering systems. Crankcase dilution, crankcase ventilation. Positive Crankcase Ventilation.

Properties and functions of a good lubricating oil. Additives. Gradation of lubricating oil due to viscosity. SAE numbers. Service rating. 2T and Super 2T oils for use in 2-s engines.

**UNIT 2**

**COOLING SYSTEM:** Necessity of cooling of I.C. engines. Methods of cooling-air cooling, water cooling, liquid cooling. Shape of cooling fins. Field of application of air cooling.

Water cooling system - Thermosiphon system, pump system, thermostat system of cooling. Thermostat - types. Radiators-different types, their construction and function. Pressurized cooling system; radiator pressure-cap, surge tank. Cooling water temperature gauge. Anti-freeze and anti-corrosive additives. Coolants. Flushing of cooling system.

**AUTOMOBILE ENGINE FUELS:** Types of fuels. Influence of structure. Calorific value. Requirements in fuels for I.C. engines. Properties. Fuel rating. Additives for S.I. and C.I. engine fuels. Specifications of petrol and diesel. Leaded and un-leaded petrol, Low Sulphur diesel. Enhancing Power output- Nitrox injection.

Non-conventional fuels - LPG, CNG ethanol-mixed petrol. Properties, method of manufacture and their performance as I.C. engine fuels. Engine modifications required. Dual mode engine.

Idea of Electric Vehicles and Hybrid Vehicles.

**UNIT 3**

**FUEL SYSTEM OF DIESEL ENGINES:** Fuel supply system. Filters (primary and secondary); positioning of filters. Feed pump. Solid and air injection system. Fuel injection pump, different types- plunger, distributor pump, their construction and working. Injectors. Governors. Types of governing. Combustion process in diesel engine. Diesel knock. Electronically Controlled Diesel Injection Pump. Common Rail Direct Injection. Piezoelectric effect and its use in CRDI.

**UNIT 4**

**FUEL SYSTEM OF PETROL ENGINES:** Gravity feed system used in 2-wheelers. Fuel supply circuit of 4-wheelers. Mechanical and electrical fuel pump. Electric fuel gauge. Petrol fuel filter. Air/fuel ratio. Variation of air/fuel ratio with speed. Air cleaners (wet & dry). Cyclone filter.

**CARBURETOR** - Function and principle of working of simple carburetor. Carburetor controls- throttle, choke. Types of Carburetors- fixed jet carburetor (Solex type) and constant vacuum carburetors used in YAMAHA motorcycle. Twin-barrel carburetors. Classification of carburetors. Disadvantages of carburetors. Phenomenon of combustion and detonation. Pre-ignition.

**UNIT 5**

**FUEL INJECTION SYSTEMS (PETROL ENGINE):** TBI, MPI; the Electronic Module. Advantages of Electronic Fuel Injection (EFI). Block diagram of the EFI. The Air Intake System and the

Idle Air Control System. Fuel Delivery System. Various sensors used with the ECM, their location and purpose. Fuel Injector. Idea of Gasoline Direct Injection

ENGINE PERFORMANCE AND TESTING: Various losses in an engine. Heat balance, Morse method of finding IHP, Calculation of various quantities like IHP, BHP, mechanical efficiency, thermal efficiency, relative efficiency, overall efficiency, specific fuel consumption. Performance curves.

### **(6.GV.06) Automotive Refrigeration & Air-conditioning**

**Unit-I: Refrigeration Fundamentals:** Introduction to refrigeration and vapour compression system, cycle diagram (Carnot cycle, Reverse Carnot cycle, Simple vapour compression cycle, bell Coleman cycle), effects of various operating parameters on performance of A/C System, Vapour absorption refrigeration system (No numerical), Applications of refrigeration and air conditioning.

**Unit-II: Refrigerants and Air conditioning Components:** Environmental concerns/Legislation for automotive A/C systems, types and properties of refrigerants, refrigerant oils, refrigerant piping. Future refrigerants, Air conditioning components: Compressors, Condensers, flow control devices, evaporators – Design guidelines, types, sizing and their installation. Accumulators, receiver driers and desiccants, Refrigerant charge capacity determination

**Unit-III: Air distribution system:** Comfort conditions, Air management and heater systems, air distribution modes (Fresh/Recirculation, Face, Foot, Defrost, and Demist), A/C ducts and air filters. Blower fans, Temperature control systems (manual/semiautomatic, automatic). Vehicle operation modes and Cool-down performance

**Psychrometry:** Psychrometric properties, tables, charts, Psychrometric processes, Processes, Combinations and Calculations, ADP, Coil Condition line, Sensible heat factor, Bypass factor.

**Unit-IV: Load analysis and control devices:** Load Analysis, Outside and inside design consideration, Factors forming the load on refrigeration and air conditioning systems, Cooling and heating load calculations, Load calculations for automobiles, Effect of air conditioning load on engine performance, Air conditioning electrical and electronic control, pressure switching devices, sensors and actuators.

**Unit-V: Diagnostics, Trouble Shooting, Service and Repair:** Initial vehicle inspection, temperature measurements, pressure gauge reading and cycle testing, leak detection and detectors, Sight glass. Refrigerant safety/handling, refrigerant recovery; recycle and charging, system oil, system flushing, odour removal, retrofitting. Removing and replacing components, Compressor service.

### **(6.GV.07) Vehicle Performance & Testing**

**Unit-I: Vehicle Performance Parameters:** Vehicle Performance parameters: Fuel economy, acceleration, deceleration, gradability, top speed, handling, comfort, life durability, EGR systems, Impact of vehicular systems on performance: Suspension system, Steering system, Brakes, Tyres, carriage unit. Catalytic converters function and construction, Lambda close loop control system for gasoline vehicles.

**Unit-II: Drive train and Component testing:** Vehicular transmission performance: comparison of automotive clutches, Epicyclic transmission, torque converter, final drive and differential, testing of vehicle components: clutch, gear box (for noise and shifting force), brake testing, wheels and tyre testing – tyre wear pattern identification and causes.

**Unit-III: Vehicle testing:** Vehicle Testing - Road test, free acceleration test, coast down test, passer by noise test, road load data acquisition for vehicle.

Test tracks: Proving ground testing, high speed track, pavement track, corrugated track, mud track, steering pad, gradient track, deep wading through shallow water

Laboratory testing: Testing on chassis dynamometer, transition testing (Euro III onwards), accelerated testing, virtual testing, evaporative emission testing, oil consumption testing, endurance test, high speed performance test.

Collisions and Crash Testing: Crash testing: Human testing, dummies, crashworthiness, pole crash testing, rear crash testing, vehicle to vehicle impact, side impact testing, crash test sensors, sensor mounting, crash test data acquisition, braking distance test.

**Unit-IV: Comfort, Convenience and Safety:** Seats: types of seats, driving controls accessibility, and driver seat anthropometry. Steering: steering column angle, collapsible steering, and power steering. Adaptive cruise control, navigation system, adaptive noise control, driver information system, Safety: Motor vehicle safety standards, active safety, passive safety, bio-mechanics Structural safety, energy absorption, ergonomic consideration in safety.

**Unit-V: Noise Vibration and EMI:** Noise and vibration: Mechanism of noise generation, engine noise and vibration, causes and remedies on road shocks, wind noise and measurement. Automobile testing instrumentation: Sensors types and selection, instrumentation for functional tests, model test and full scale testing.

## (6.GV.08) Electrical & Hybrid Vehicles – II

**Unit -I: Hybrid Architecture and Power Plant Specifications:** Series configuration locomotive drives- series parallel switching- load tracking architecture. Pre transmission parallel and combined configurations Mild hybrid- power assist- dual mode- power split- power split with shift- Continuously Variable transmission (CVT)- wheel motors. Grade and cruise targets- launching and boosting- braking and energy recuperation- drive cycle implications.

**Unit -II: Sizing the Drive System and Energy Storage Technology:** Matching electric drive and ICE; sizing the propulsion motor; sizing power electronics. Battery basics; lead acid battery; different types of batteries; battery parameters

**Unit-III: Fuel Cells:** Fuel cell characteristics- fuel cell types – alkaline fuel cell- proton exchange Membrane; direct methanol fuel cell- phosphoric acid fuel cell- molten carbonate fuel cell- solid oxide fuel cell- hydrogen storage systems- reformers- fuel cell EV- super and ultra capacitors- PEM fuel cell vehicles.

**Unit IV: Energy Storage:** Battery based energy storage: Battery basics, Lead acid (Pb-Acid) battery, Nickel-Cadmium (NiCd) battery, Nickel-Metal-Hydride (NiMH) battery, Lithium-ion (Li-ion) battery, Lithium-polymer (Li-poly) battery, Ultra capacitors.

**Unit -V: Nonelectric Hybrid Systems:** Short term storage systems flywheel accumulators. continuously variable transmissions hydraulic accumulators hydraulic pumps/motors- pneumatic hybrid engine systems operation modes.



**(6.VP.03) Automotive RAC Lab.**

1. Test on vapor compression test rig.
2. Test on air conditioning test rig.
3. Study of various methods of transport refrigeration systems.
4. Study and demonstration on car and bus air conditioning system.
5. Study of latest trends in automotive refrigeration systems.
6. Study and demonstration of controls in refrigeration.
7. Study of different components with the help of cut sections/models/charts- Compressor, Condenser, Evaporators, Expansion device, Blower fans, Heating systems etc.
8. Study of installation/operations/maintenance practices for refrigeration systems.
9. Study of leak testing and leak detection methods.
10. Visit to maintenance shop of automotive air conditioning and writing report on it.

**(6.VP.04) Vehicle Performance & Testing Lab**

1. Estimation of power requirement for vehicle propulsion by taking actual vehicle example.
2. Perform coast down test to find vehicle inertia.
3. On road fuel consumption test at different speeds.
4. Brake efficiency measurement
5. Pass- by noise test.
6. Free acceleration test.
7. Vibration measurement in passenger compartment
8. Laboratory testing of vehicle on chassis dynamometer for performance
9. Laboratory testing of vehicle on chassis dynamometer for emission.
10. Report based on visit to vehicle testing and research organization.
11. On road emission testing of petrol and diesel vehicles for PUC/RTO

**Level 7 (Semester I)****(7.GV.01) Automotive System Design**

**Unit-I: Design of Clutches & Gearbox:** Design requirements of friction clutches, selection criterion, torque transmission capacity, lining materials, Design of single plate clutch, multi-plate clutch and centrifugal clutch. Selection of gear ratios and final drive ratio, numerical on 3- speed and 4- speed gearbox.

**Unit-II: Design of Propeller Shafts and Axles:** Design of propeller shafts for bending, torsion and rigidity, Design of universal joints and slip joints, final drive, Design of live and dead axles.

**Unit-III: Brake Systems:** Design of hydraulic braking system, internal expanding shoe brake and disc brake, design of master and wheel cylinder and piping design.

**Unit-IV: Design of Suspension and Steering System:** General design considerations of suspension system, design of helical and leaf springs for automobile suspension system, design considerations of belleville springs, elastomeric springs, design considerations of steering system and vehicle frame design.

**Unit-V: Statistical Consideration in Design and Optimization:** Ergonomics and aesthetic design, statistics in design, design for natural tolerances, statistical analysis, and mechanical reliability, introduction to design optimization of mechanical elements, adequate and optimum design, methods of optimization, johnson's method of optimum design-simple problems in optimum design like axially loaded members.

**(7.GV.02) Plant Layout & Product Handling**

Objective of Facility Design: Types of layout problems, the layout function, organization of layout. Analysis and Design of Material Flow: Systems approach to flow cycle, process charts, flow process charts, Quantitative analysis of material flow; optimal material flow configuration. Space and Area Allocation for Production and Physical Plant Services;

Computerized handling of layout algorithms; Algorithms for computerized Layout Planning, Construction and Development type of computerized Layout Planning Techniques i.e. CRAFT, ALDEP, CORELAP etc.;

Product handling; Design of system configurations conforming to various kinds of product features and layout characteristics; Design concepts of common handling and transfer equipment; Different types of conveyors, elevators, fork lifters;

Design concept of warehouse facilities commensurate with adopted kind of handling and transfer devices; Automated Handling of materials, Automated Transfer lines, AGVS, Use of Robots in Product handling, automated packaging devices.

Application of pneumatic and hydraulic system in transportation and handling of products, Design of integrated plant layout for product handling systems

**(7.GV.03) Industrial Engineering & Safety Engineering****UNIT 1**

**INSPECTION:** Inspection and its objective. Types of inspection. Inspection standards. Duties of inspection foreman.

**QUALITY CONTROL:** Concept of quality control. elements of quality control, quality control groups, objectives of quality control. Statistical quality control, objectives of S.Q.C. Inspection by variables & attributes. Frequency distribution, mean, median & mode, standard deviation, X-R charts, P-Charts, C-Charts and acceptance sampling. (i) I.S.O. 9000 (ii) KAIZEN (iii) Six Sigma (iv) 5S (v) TQM system, concept & brief idea only

**UNIT 2**

**WORK STUDY:** Method study-Process chart, Flow process chart, Flow diagram, Man and Machine chart, gang process chart, Work Measurement-Time study, Tools used in time study, Performance rating, Allowance and use of time standard, Time and Motion Study. Principles of human motion economy, Micro-motion study, Memo motion study, Therbligs, left hand and right hand chart.

**UNIT 3**

**CPM & PERT:** Introduction to CPM, language of CPM net work. Diagram map for CPM chart, arrow diagram method of CPM, Programme Evaluation & Review Technique (PERT) Activity event net work (simple manual cases only). Project scheduling with CPM & PERT.

**UNIT 4**

**PLANT LAYOUT:** General plant location factors, Influence of location on plant layout, selection of plant site, Product layout, Process layout. Advantages and disadvantages of process layout and product layout.

**GENERAL:** Standardization, sources of standard, value of standardization. Production Planning & Control-Introduction, concept of planning, scheduling routing & despatching and follow up functions. Need for Production, Planning and Control.

**UNIT 5**

**MATERIAL HANDLING:** Material Handling & material handling equipment, factors in material handling problems, cost reduction through improved material handling, Reduction in time of material handling, Material handling equipment-Idea about lifting lowering devices, Transportation devices, combination devices, Maintenance of material handling equipment.

**INDUSTRIAL SAFETY:** Need for safety-Legal, humanitarian, economic and social considerations. Safe working conditions and productivity, Unsafe conditions and hazards.

**Safety Engineering-General safety devices used on machines, Manual handling and storage of material. Mechanical handling of materials. Value Engineering, Meaning of Value, Value Analysis, reasons for unnecessary costs, selection of a product for value engineering. Data collection and analysis. TEN Commandments of Value Engineering. Brief idea of J.I.T. manufacturing and Kanban System.**

**(7.GV.04) CAD & CAM****1. Introduction CIM and CAD & Analysis:**

**CIM:** Introduction of CIM- concept of CIM - evolution of CIM – CIM wheel –Benefits – integrated CAD/CAM. **CAD:** Introduction- CAD definition – Shigley's design process –

CAD activities – benefits of CAD. Types of CAD systems, CAD software packages, 2D & 3D transformations, Geometric modeling: Techniques: Wire frame modeling – surface modeling – solid modeling

## 2. Computer aided Manufacturing

CAM: Definition, functions, benefits. Group technology – Part families - Parts classification and coding - coding structure – Optiz system, MICLASS system and CODE System - process planning – CAPP – Types of CAPP : Variant type, Generative type – advantages of CAPP – production planning and control – computer integrated production management system – Master Production Schedule (MPS) – Capacity planning – Materials Requirement Planning (MRP) –Manufacturing Resources Planning (MRP-II)

## 3. CNC Machine and Components:

CNC Machines: Numerical control – definition – components of NC systems – development of NC – DNC – Adaptive control systems – working principle of a CNC system – Features of CNC machines - advantage of CNC machines – difference between NC and CNC – Construction and working principle of turning centre – Construction and working principle of machining centers – machine axes conventions turning centre and machining centre – design considerations of NC machine tools.

## 4. Part Programming

NC part programming – methods – manual programming – conversational programming – APT programming - Format: sequential and word address formats - sequence number – coordinate system – types of motion control: point-to-point, paraxial and contouring – Datum points: machine zero, work zero, tool zero NC dimensioning – reference points – tool material – tool inserts - tool offsets and compensation - NC dimensioning – preparatory functions and G codes, miscellaneous functions and M codes – interpolation: linear interpolation and circular interpolation.

## 5. FMS, Integrated Material Handling and Robot:

Types of manufacturing - introduction to FMS – FMS components – FMS layouts – Types of FMS: flexible manufacturing cell – flexible turning cell – flexible transfer line – flexible machining systems – benefits of FMS - introduction to intelligent manufacturing system – virtual machining. Computer Integrated material handling – AGV: working principle – types, benefits – Automatic Storage and Retrieval Systems (ASRS).ROBOT – definition – robot configurations – basic robot motion – robot programming method – robotic sensors - industrial applications: characteristics, material transfer, machine loading, welding, spray coating, assembly and inspection.

### **(7.VP.01) CAD & CAM Lab**

- Introduction and different features of the CAD Software.
- 2-D Drafting.
- 3-D Modeling.
- 3-D Advanced Modeling.
- Assembly modeling.
- Feature Modification and Manipulation
- Detailing.

- Sheet Metal Operations.
- Surface Modeling
- To prepare part programming for plain turning operation.
- To prepare part programming for turning operation in absolute mode.
- To prepare part program in inch mode for plain turning operation.
- To prepare part program for taper turning operation.
- To prepare part program for turning operations using turning cycle.
- To prepare part program for threading operation.
- To prepare part program for slot milling operation.
- To prepare part program for gear cutting operation.
- To prepare part program for gear cutting using mill cycle.
- To prepare part program for drilling operation.

### **(7.VP.02) Design of Automotive Systems Lab**

1. Design of automotive clutch assembly and component drawing using any drafting software (Two full imperial sheets along with design calculations report) consists of:
  - Functional design of clutch
  - Design of clutch shaft, hub and flange
  - Design of damper springs
  - Design of sectors, rivets etc.
  - Design of pressure plate assembly
  - Design for linkage mechanism
  - Details and assembly drawing
  - Details and assembly drawing
3. Design of automotive gear box along with reverse gear (Two full imperial sheets along with design calculations report) consists of:
  - Calculation of gear ratios
  - Determination of number of teeth on gear pair
  - Determination of gear reductions
  - Design of gear pairs
  - Design of shafts
  - Selection of bearings
  - Details and assembly drawing
4. Design of suspension spring and its analysis using any analysis software.

**Level 7 (Semester II)**

**(7.GV.05) Vehicle Safety**

Unit 1

Introduction to vehicle safety, Basic concepts of vehicle safety, Risk evaluation and communication

Human error control, Universal design, The distracted driver, Crash Testing

Unit 2

Accident Data, Biomechanics and Occupant Simulation, Vehicle Body Testing, Dynamic Vehicle Simulation Tests, Occupant Protection, Pedestrian Protection, Compatibility, Interrelationship Among Occupants, Restraint Systems and Vehicle in Accidents, Significance of Rear Crash Safety, Role of seat in Rear crash safety, Performance criteria for different seats, Ultra high Retention seats

Unit 3

Introduction to Accident Analysis Reconstruction methods, Uncertainty in Measurement and cautions

Tire forces, Straight-line Motion, Critical speed from Tire Yaw marks, Reconstruction of Vehicular Rollover Accidents, Analysis of Collisions, Reconstruction Applications, Impulse Momentum Theory

Crush Energy, Frontal Vehicle –Pedestrian Collision, Photogrammetry for accident constructions

Unit 4

Antilock braking system, Traction control system, Electronic Stability Program, Low tire pressure warning system, Collision avoidance systems

Unit 5

Automotive Industry Standards, Transport Engineering Standards, Indian road congress Standards

**(7.GV.06) Agile and Lean Manufacturing**

**1. Introduction-**

Introduction to Just in time production, Toyota production system, Introduction to lean manufacturing (LM), history of LM, advantages of LM over mass production

**2. Waste Identification-**

Types of wastes, lean manufacturing principles; Value, value stream, flow, pull and perfection

**3. Value stream mapping-**

Introduction to value stream mapping, types of value stream mapping, value added activities, necessary non value added activities, non-value added activities

**4. Lean manufacturing tools-**

Introduction to 5S, Kanban, kaizen, work standardization, Statistical process control, automation and other lean tools

**5. Agile manufacturing-**

Introduction to agile manufacturing, advantages of agile manufacturing, differences with lean manufacturing.

### **(7.GV.07) Process Planning and Control**

#### **1. Demand Forecasting-**

Introduction, components of forecasting demand, Approaches to forecasting: forecasts based on judgment and opinion, Selection of forecasting technique.

#### **2. Capacity Planning-**

Defining and measuring capacity, determinants of effective capacity, capacity strategy, steps in capacity planning process, determining capacity requirements, Capacity alternatives, Evaluation of alternatives; Cost-Volume analysis.

#### **3. Facility Location-**

Need for location decisions, factors affecting location, qualitative and quantitative techniques of location. Facilities layout: Product, Process, Fixed position, combination and cellular layouts; Designing product and process layout, line balancing.

#### **4. Production Control-**

Capacity control and priority control, production control functions; Routing, scheduling, dispatching, expediting and follow up, Techniques of production control in job shop production, batch production and mass production systems

#### **5. Sequencing-**

Priority rules, sequencing methods, sequence jobs through two work centers, scheduling services, application of CPM and PERT techniques.

### **(7.VP.03) Project**

On the basis of learning in the Bachelor of Vocational, a project to be taken up by the student strengthening his/ her vocational skills