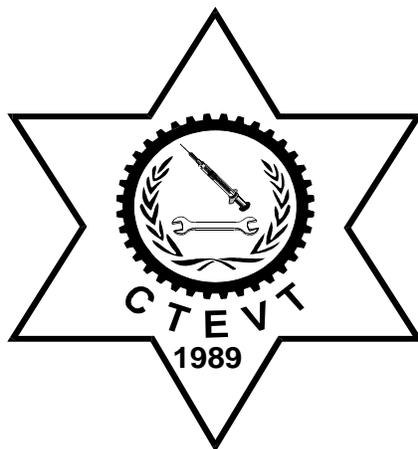


# **CURRICULUM**

## **Technical School Leaving Certificate**

### **Automobile Engineering**

#### **(Apprenticeship Programme)**



**Council for Technical Education & Vocational Training (CTEVT)**

**Curriculum Development Division**

**Sanothimi, Bhaktapur**

**2019**

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## **Introduction:**

TSLC Curriculum in Automobile Engineering is designed to produce entry level workforce in Automobile sector. The graduates will be equipped with required knowledge, skills and attitude necessary to this level to meet the demand of the Automobile repair center and workshop in the country and abroad. This curriculum is based on the apprenticeship model in which trainees involve in the real work practice in the industry. An apprenticeship program combines on-the-job training with academic instruction for those entering the workforce. It is also called dual-training programs because of the combined occupational and in-house components; apprenticeships help individuals put their academic skills to practical use in various careers.

The program extends over 24 months. First fifteen weeks in-house classes insist in theoretical and basic practical skills will be provided in training institutes. They learn the theoretical foundational subjects, communications and soft skills. The trainees acquire theoretical knowledge and do practical in the training institutes. In every subject, topical explanations will be followed by demonstrations by instructors and in all tasks, trainees will be asked to practice by themselves through do-it-yourself/hands-on exercises so that they can internalize what they learn in the classroom.

After completing the fifteen weeks classes in training institutes, students are placed in Automotive Repairing Center or Workshop for 78 weeks (5 days a week and 8 hours a day) for real practice and they are called in training institute for 1 day a week, where they get some theoretical and practical exposure they find necessary. After the completion of 78 weeks' industrial practice, apprentice students come back to the training institute for the revision and exam preparation for 4 weeks as block release.

Admitted trainees will have the three parties training agreement among trainees, sponsor industries and training institute. The Agreement term and conditions will be implemented during the whole training period.

## **Rational**

The automobile Engineering is genuine field in the engineering and technology sector. Many people in the world have been given emphasis for the broader application of automobile. This sector has been helping the world for the overall development and it has been creating wage and self employment opportunities both in public and private sectors. Nepal is lacking huge number of trained workforce in automobile sector. In the one hand, large number of foreign workers are working in Nepalese automobile industries and in the other hand, huge number of workforce are migrated abroad for employment as unskilled workers with minimum wages.

Very few Nepalese workers are working in automobile sector at present without well trained. They are not able to fulfil the needs of industries due to the lack of skills and knowledge on latest technology. This curriculum is designed as apprenticeship model with the involvement of experts from automobile industries. Based on this curriculum, students will acquired required skills and knowledge in real work of world and fulfil the skills gap of the industries. This apprenticeship curriculum prepares graduates apt to the industry need, so that they get employed and poverty will be elevated. Moreover the automobile industries have agreed to develop the curriculum and train the students as apprentice so that they won't have the scarcity of skilled workers updated with their technologies in low cost.

## Course Title:

TSLC in Automobile Engineering (Apprenticeship Programme)

## Aim:

The aim of this programme is to produce competent workforce equipped with automotive skills and knowledge to undertake any automobile repairing center or workshop or business company.

## Objectives:

This curriculum has following objectives to:

- Produce basic level competent workforce in the field of automobile engineering who will be able to;
  - Repair and maintain automobile vehicles.
  - Repair and maintain various automobile components.
  - Assemble /disassemble various automobile systems.
  - Familiarize with auto electrical and electronics system.
  - Troubleshoot the automobile system.
- Prepare such technicians who are able to work in the automobile sector related local workshop and industrial settings of the country.
- Prepare such technical workforce who will demonstrate positive attitude and respect for the profession and socio-cultural values.
- Meet the demand of such technical workforce for the automobile industries of Nepal.
- Reduce the dependence on employing such technicians from foreign countries.
- Create self-employment opportunities.

## Course Duration

This course will be completed within 24 months after the enrolment in a formal setting.

The total hours for the course will be 4378 hours in the 24 months of period. Pre-training course (maximum 15 weeks) and at the last month of the whole course Block Release Training (maximum 4 weeks) programme will be conducted in the Institute. Industrial Practice & related skills will be learnt in the related sponsor industries.

The details of the course duration are as follows:

### A. Institute Based Instruction:

**1258 hours**

- Pre training course: 15 weeks (600 hours)
- One day/week for 78 weeks: 78 days (498 hours)
- Block Release: 4 weeks (160 hours)

### B. Industry Based Training (Hands on Practice):

**3120 hours**

- Control & Suspension System: 10 weeks (400 hours)
- Power Trains: 10 weeks (400 hours)
- Automotive Engine: 16 weeks (640 hours)
- Auto Electrical & Electronics System: 10 weeks (400 hours)
- Automobile Body shop Repair: 8 weeks (320 hours)
- Specialization in Any/All Department: 24 weeks (960 hours)

## **Entry Criteria:**

Individuals with following criteria will be eligible for this program:

- SEE with any grade and any GPA (Since 2072 SLC).
- SLC appeared (Before 2072 SLC).
- Nepali citizen above 16 years of age.
- Pass entrance examination administered by CTEVT.
- Candidates will be recruited on the merit base of entrance examination.
- Selected candidates should pass the interview conducted jointly by industry and the training institute.
- Mentally & physically sound.

## **Group size:**

The group size of this program will be 40.

## **Medium of Instruction:**

The medium of instruction will be in English and/or Nepali language.

## **Pattern of Attendance:**

The students should have 90% attendance in theory classes and 100% in practical/industrial practice to be eligible for internal assessments and final examinations.

## **Instructors' Qualification**

- Bachelor's degree in Automobile Engineering or Diploma in Automobile Engineering with three years' experience.  
*Preferable Skills:*
- Good communication/instructional skills
- Experience in the related field

## **Teacher and Student Ratio:**

- Overall ratio of teacher and student must be 1:10 (at the institution level).
- Teacher and students ratio for theory class should be as per nature of classroom
- Teacher and student ratio for practical should be 1:10
- Minimum 75% of the teachers must be fulltime.

## **Instructional Media and Materials:**

The following instructional media and materials are suggested for the effective instruction, demonstration and practical.

- Printed Media Materials (Assignment sheets, Handouts, Information sheets, Individual training packets, Procedure sheets, Performance Check lists, Textbooks etc.).
- Non-projected Media Materials (Display, Photographs, Flip chart, Poster, Writing board etc.).
- Projected Media Materials (Multimedia, Overhead transparencies, Slides etc.).
- Computer-Based Instructional Materials (Computer-based training, Interactive video etc.)

## Teaching Learning Methodologies:

The methods of teaching for this curricular program will be a combination of several approaches such as:

- Theory: Lecture, group discussion, Assignment, Group work.
- Practical: Demonstration, Observation and Self-practice, guided practice, tutorial.
- Industrial Practice: Real practice under the supervision of Industrial Supervisor.

## Evaluation Details:

- The distribution of marks for theory and practical tests will be as per the marks given in the course structure of this curriculum for each subject. Ratio of internal and final evaluation is as follows:

S.N.	Particulars	Internal Assessment	Final Exam	Pass %
1	Theory	50%	50%	40%
2	Practical	50%	50%	60%
3	Industrial Practice	100%		60%

- There will be three internal assessments conducted by institute and one final examination in each subject at the end of programme. Moreover, the mode of assessment and examination includes both theory and practical or as per the nature of instruction as mentioned in the course structure.
- Every student must pass every internal assessment to appear the final exam.
- Continuous evaluation of the students' performance is to be done by the related instructor/ trainer/industrial supervisor to ensure the proficiency over each competency under each area of a subject specified in the curriculum.
- Performance evaluation of industrial practice should be done by the related In-company Trainer (Industrial Supervisor).

## Grading System:

The grading system will be as follows:

### Grading

Distinction  
First division  
Second division  
Third division

### Overall marks

80% or above  
75% to below 80%  
65% to below 75%  
Pass aggregate to below 65%

## Certificate Awarded:

The council for technical education and vocational training will award certificate of “**Technical School Leaving Certificate in Automobile Engineering (Apprenticeship)**” to those students who have successfully completed the requirements as prescribed by the curriculum.

## Career Path:

The graduate will be eligible for the position equivalent to Non-gazetted 2nd class/level 4 (technical) in the government related organizations or as prescribed by the Public Service Commission of Nepal or the concerned authorities (Automotive Industries) of the Federal Democratic Republic of Nepal.

## Course Structure

S. N	Subjects	Nature	Hours/ Week			Total Hours			Remarks
			T	P	Total	T	P	Total	
<b>A. Institute Based Training (3.5 Months – 1 to 15 Weeks )</b>									
1.	<b>Workshop Technology</b>	T+P	3	6	9	45	90	135	
2.	<b>Engineering Drawing</b>	P	0	4	4	0	60	60	
3.	Control & Suspension System	T+P	2	2	4	30	30	60	
4.	Power Trains	T+P	2	2	4	30	30	60	
5.	Automotive Engine	T+P	2	2	4	30	30	60	
6.	Auto Electrical & Electronics System	T+P	2	2	4	30	30	60	
7.	Applied Math	T	5	0	5	75	0	75	
8.	Applied Communication & Professionalism	T+P	4	2	6	60	30	90	
	<b>Sub Total</b>		<b>20</b>	<b>20</b>	<b>40</b>	<b>300</b>	<b>300</b>	<b>600</b>	
<b>B. Institute Based Class @ 1 day a week (16 to 93 Week - 78 weeks) 78 days</b>									
1.	Control & Suspension System	T+P				42	54	96	
2.	Power Trains	T+P				42	54	96	
3.	Automotive Engine	T+P				42	54	96	
4.	Auto Electrical & Electronics System	T+P				42	54	96	
5.	Automobile Body Shop Repair	T+P				42	72	114	
	Sub Total					<b>210</b>	<b>288</b>	<b>498</b>	
<b>C. Industrial Practices @ 5 days a week (16 to 93 Week - 78 weeks)</b>									
1.	Control & Suspension System	P					400	400	10 Weeks
2.	Power Trains	P					400	400	10 Weeks
3.	Automotive Engine	P					640	640	16 Weeks
4.	Auto Electrical & Electronics System	P					400	400	10 Weeks
5.	Automobile Body Shop Repair	P					320	320	8 Weeks
6.	Any/all five Departments as per the requirement of Industry and interest of the students (24 weeks)	P					960	960	24 Weeks
	Sub Total						<b>3120</b>	<b>3120</b>	78 Weeks
<b>D.</b>	<b>Block Release (94 to 97 Week - 4 weeks)</b>	<b>T+P</b>				80	80	160	
<b>E.</b>	<b>Exam Preparation and Final Exam (7 Weeks)</b>								
	Sub Total								
	<b>Grand Total</b>					<b>590</b>	<b>3788</b>	<b>4378</b>	

## Evaluation Scheme

S.N.	Subjects	Nature	Total Hours			Full Marks		
			T	P	Total	T	P	Total
<b>A.</b>	<b>Institute based Training (15 Weeks + 1 day/week for 78 weeks)</b>							
1	Workshop Technology	T+P	45	90	135	50	50	100
2	Engineering Drawing	P	0	60	60	0	50	50
3	Control & Suspension System	T+P	72	84	156	50	50	100
4	Power Trains	T+P	72	84	156	50	50	100
5	Automotive Engine	T+P	72	84	156	50	50	100
6	Auto Electrical & Electronics System	T+P	72	84	156	50	50	100
7	Automobile Body Shop Repair	T+P	42	72	114	25	25	50
8	Applied Math	T	75	0	75	50	0	50
9	Applied Communication & Professionalism	T+P	60	30	90	25	25	50
	<b>Sub Total</b>		<b>510</b>	<b>588</b>	<b>1098</b>	<b>350</b>	<b>350</b>	<b>700</b>
<b>B.</b>	<b>Industry Based Training (78 weeks @ 40 hours/week)</b>							
1	Control & Suspension System	P		400	400		200	200
2	Power Trains	P		400	400		200	200
3	Automotive Engine	P		640	640		200	200
4	Auto Electrical & Electronics System	P		400	400		200	200
5	Automobile Body Shop Repair	P		320	320		200	200
6	Any/all five Departments as per the requirement of Industry and interest of the students (24 weeks)	P		960	960		300	300
	<b>Sub Total</b>			<b>3120</b>	<b>3120</b>		<b>1300</b>	<b>1300</b>
<b>C.</b>	<b>Block Release (4 weeks @ 40 hrs/week)</b>							
	<b>Grand Total</b>		<b>590</b>	<b>3788</b>	<b>4378</b>	<b>245</b>	<b>1755</b>	<b>2000</b>

# Workshop Technology

**Total Class: 135 hrs**

**Theory: 45 hrs**

**Practical: 90 hrs**

## **Course description:**

This subject deals with theory and practical on basic hand tools, measuring instrument, power tools required in automobile workshop practice. This subject aims at imparting general knowledge and skills to the student making them competent and potential in the field of applied mechanical fitting and machining works.

## **Course content**

### **THEORY**

- 1. Workshop safety & First Aid** [4 hrs]
  - 1.1. Introduction and Types of safety: Personnel, machine, working environment
  - 1.2. Occupational health and safety
  - 1.3. Electrical safety
  - 1.4. Fire hazards and fighting equipment
  - 1.5. First Aid on: electric shock, simple cut and injuries
  
- 2. Bench work hand tools** [6 hrs]
  - 2.1. Hammer: types, uses
  - 2.2. Chisels and chippings: types, uses
  - 2.3. Punches: types, uses
  - 2.4. Pliers and cutters: types, uses
  - 2.5. Wrench and spanners: types, uses
  - 2.6. Vices: types, uses and main parts
  - 2.7. C-clamps: types, uses
  - 2.8. V- Block with clamps
  - 2.9. Safety precautions
  
- 3. Measuring instruments** [6 hrs]
  - 3.1. Scales and meters: uses, importance, types
  - 3.2. Calipers: uses, types
  - 3.3. Vernier calipers: working and components
  - 3.4. Micrometers: working and components
  - 3.5. Gauges (feeler gauge, radius gauge, pitch and bore gauge) and their uses
  - 3.6. Angle measuring instruments: simple and bevel protractor
  - 3.7. Care of measuring instruments
  
- 4. Basic bench work operations** [6 hrs]
  - 4.1. Hacksaw and sawing

- 4.2. File and it's type: according to size, cross section, cut of teeth, grade cut
- 4.3. Methods of filling
- 4.4. Taps and dies : types, uses, size of tap drills
- 4.5. Internal and external threading process
- 4.6. Basic sheet metal operations: Measuring, marking, cutting, seaming, folding, Riveting
- 4.7. Safety precautions

**5. Drills and drilling operation** **[4 hrs]**

- 5.1. Drill bits: types and parts
- 5.2. Drill machines: types and parts
- 5.3. Cutting speed feed and RPM
- 5.4. Drilling operations
- 5.5. Safety precautions

**6. Welding** **[12 hrs]**

- 6.1. Welding and types
- 6.2. Welding joints, symbols and positions
- 6.3. Electric arc welding: working, components and accessories
- 6.4. Oxy-Acetylene gas welding: working, components and accessories
- 6.5. Spot Resistance welding: working, components and accessories
- 6.6. Soldering: working, components and accessories
- 6.7. Brazing: working, components and accessories
- 6.8. Welding defects and their control
- 6.9. Safety precautions

**7. Workshop Machines and typical care on repairing** **[7 hrs]**

- 7.1. Lathe Machine: Working, Components, Operations and Uses
- 7.2. Honing: Working, Components and Uses
- 7.3. Hydraulic Press: Working, Components, Operations and Uses
- 7.4. Typical care on repairing:
  - 7.4.1. Use of Bearing puller and vice grip
  - 7.4.2. Hydraulic lock
  - 7.4.3. Studs on cylinder

**References:**

- 1. Workshop Technology (Vol. I and II) By S. K. and A.K. Hajra Chaudhary
- 2. Shop Theory (Vol. 1) By Henp Fort Trade School
- 3. Fitter trade Practical, CIMI, Madras
- 4. Mechanical engineering, ILO learning element
- 5. All about MACHINE TOOLS, Heinrich Gerling
- 6. Elementary Metal Course Training Section I, BBF.

## PRACTICAL

S. N.	Assignment	Hours	Tasks/Skills
1	Workshop Safety	4	<ol style="list-style-type: none"> <li>1. Orient with personal safety /hygiene</li> <li>2. Fix safety notices/signs</li> <li>3. Follow safety precautions/instructions</li> <li>4. Maintain first aid box</li> <li>5. Prevent electrical hazard</li> <li>6. Apply first aid</li> <li>7. Use fire extinguisher</li> <li>8. Follow good safety practices (personal safety and proper machine operation)</li> </ol>
2	Measurement	4	Measure the dimensions of given object using <ol style="list-style-type: none"> <li>1. Steel rule and Tapes</li> <li>2. Vernier caliper</li> <li>3. Micrometer</li> <li>4. Protector</li> <li>5. Radius gauge</li> </ol>
3	Bench Work operations	18	<ol style="list-style-type: none"> <li>1. Interpret simple Mechanical Drawing in bench work operations</li> <li>2. Measure &amp; mark the given object as per drawing</li> <li>3. Use of Saw for cutting metal by hand</li> <li>4. Use of grinding machine on metal surfaces to clean the rust and burrs.</li> <li>5. Use of center punch for drilling</li> <li>6. Use of chisel on flat surface chipping</li> <li>7. Use of taps and dies to cut threads</li> <li>8. Use of different files on flat, round and inner surfaces</li> <li>9. Perform sheet metal work using hand shear, rivets, folding and seaming process, soldering</li> <li>10. Make minimum two products from combinations on bench work.</li> </ol>
4	Drilling operation	4	<ol style="list-style-type: none"> <li>1. Selection of drill bit for different hole size</li> <li>2. Replacing drill bit and chuck</li> <li>3. Selection of speed for different drilling operations</li> <li>4. Placing and holding the drilling objects</li> <li>5. Marking a drilling position using a center punch</li> <li>6. Perform drilling, counter boring, Reaming</li> <li>7. Perform cleaning of drilled hole</li> </ol>
5	Arc Welding	24	<ol style="list-style-type: none"> <li>1. Use of welding safety equipment's</li> <li>2. Prepare A/C arc welding machine, tools &amp; equipment's.</li> <li>3. Selecting the welding position</li> </ol>

			<ol style="list-style-type: none"> <li>4. Striking and maintain the arc</li> <li>5. Perform Straight bead in flat position</li> <li>6. Weld Fillet Lap joint in flat position</li> <li>7. Weld Fillet Tee joint in flat position</li> <li>8. Weld Fillet Corner joint in flat position</li> <li>9. Weld square butt joint in flat position</li> <li>10. Weld single V-butt joint in flat position</li> <li>11. Weld double bevel joint in flat position</li> <li>12. Weld Flange joint in flat position</li> <li>13. Perform straight bead in horizontal vertical position</li> <li>14. Weld square butt joint in horizontal vertical position</li> <li>15. Perform straight bead in vertical position (up &amp; down)</li> <li>16. Weld single 'V' butt joint with backing in vertical position</li> <li>17. Perform straight bead in overhead position</li> <li>18. Weld Square Butt Joint in overhead position</li> <li>19. Weld on cast iron parts</li> <li>20. Grind – off welding surfaces</li> </ol>
6	Gas welding	16	<ol style="list-style-type: none"> <li>1. Prepare Acetylene gas and safety equipment</li> <li>2. Set up Oxygen gas and Rubber hose</li> <li>3. Set up Welding Nozzles</li> <li>4. Run fusion lines without filler rod</li> <li>5. Run fusion lines with filler rod</li> <li>6. Weld Butt joint in flat position</li> <li>7. Weld Corner joint in Flat position</li> <li>8. Weld Lap joint in the Flat position</li> <li>9. Weld T – Joint in the Flat Position</li> <li>10. Cut straight line in MS plate manually</li> <li>11. Braze brass in Mild steel plate</li> <li>12. Braze Butt joint in Copper plate</li> <li>13. Braze Butt joint in Brass plate</li> </ol>
7	Workshop Machines	20	<ol style="list-style-type: none"> <li>1. Perform selection of speed, depth of cut and feed on lathe machine.</li> <li>2. Perform grinding of cutting tool for lathe.</li> <li>3. Perform job fixing and centering on three and four jaw chuck of lathe machine.</li> <li>4. Perform straight and step turning, facing, boring and knurling.</li> <li>5. Use of inside and outside caliper.</li> <li>6. Use of bearing puller</li> <li>7. Use of vice grip and dial gauges</li> </ol>

# Engineering Drawing

**Total Class: 60 hrs.**

**Theory: 0 hrs.**

**Practical: 60 hrs**

## Course Description:

This course deals with the engineering drawing as well as freehand sketch on automobiles system, component and assembly units. The course helps to enhance the skills and knowledge to understand drafting and designing sketch of automobile machinery parts, and hydraulic circuits related to automobile repairing work.

## Module 1: Engineering scale drawing

- 1. Introduce engineering drawing** **3 hrs.**
  - 1.1. Introduce drawing
  - 1.2. Introduce engineering instrument
  - 1.3. Introduce conventional line types
  - 1.4. Introduce drawing scale
  - 1.5. Introduce drawing sheet size
  
- 2. Handle engineering drawing instruments** **4 hrs.**
  - 2.1. Set up paper in drawing board
  - 2.2. Prepare a drawing sheet using T set and set square
  - 2.3. Draw representative lines
  - 2.4. Draw circle using compass
  - 2.5. Draw square / rectangle using set square and T set.
  - 2.6. Draw triangle using T set, set-square and protractor.
  - 2.7. Write engineering letter
  
- 3. Construct Geometric Drawing** **6 hrs.**
  - 3.1. Bisect/trisect a line.
  - 3.2. Bisect/trisect an angle
  - 3.3. Draw perpendicular and parallel line
  - 3.4. Construct regular polygons(inscribed/circumscribed/T-set and set square)
  - 3.5. Draw tangents(circle to circle, line to circle, arc to line)
  - 3.6. Construct ellipse(four center method/rhombus method)
  - 3.7. Construct oval
  
- 4. Draw orthographic view using isometric triode** **10 hrs.**
  - 4.1. Draw three view drawings from given isometric/oblique drawing
  - 4.2. Draw two view drawings of cylindrical object
  
- 5. Draw pictorial projection** **10 hrs.**
  - 5.1. Draw oblique projection
  - 5.2. Draw isometric projection

## Module 2 General Sketch

- 6. Draw section views** **12 hrs.**
- 6.1. Draw full section views
  - 6.2. Draw half section views
  - 6.3. Draw part section views
  - 6.4. Detail workshop drawing of machine parts
  - 6.5. Assembly drawing
  - 6.6. Exploded drawing of simple machine
- 7. Hydraulic Circuit (use in Automobile)** **6 hrs.**
- 7.1. Symbols of Hydraulic circuit use in Automobile  
Line-flow line and Pilot drain, pump motor and measuring device Pressure control and directional control, filter separator lubricator heat exchanger, spring, flowrestriction, directional fluid flow and pneumatic flow, Pump and compressor- fixed displacement hydraulic pumps variable displacement hydraulic pumps- unidirectional bidirectional, Motors- unidirectional and bidirectional, directional valve controls, control methods- manual control and automatic controls ,Check valve, shuttle valve, rapid exhaust valve, pressure control valves, flow control, Valves accumulators
  - 7.2. Open center hydraulic system
  - 7.3. Closed center hydraulic system
  - 7.4. General hydraulic circuit of power steering
  - 7.5. Simple circuit of hydraulic brakes and clutches
  - 7.6. General sketch of automatic transmission
  - 7.7. Simple circuit of Power take off
- 8. Machine elements free hand drawing** **4 hrs.**
- 8.1. Screw, thread, nut and bolt
  - 8.2. Gear
  - 8.3. Keys, splines, cutter and pin
  - 8.4. Bearing, coupling, journal
  - 8.5. Spring
  - 8.6. Connecting rod
  - 8.7. Pistons
  - 8.8. Eccentric shaft/cam shaft
  - 8.9. Rivets
  - 8.10. Welding and material symbols
- 9. Automotive parts drawing** **5 hrs.**
- 9.1. Simple sketch of
  - 9.2. Four stroke diesel/petrol engine
  - 9.3. Two stroke engine
  - 9.4. Differential unit
  - 9.5. Gear box unit
  - 9.6. Power train unit

**References:**

1. Engineering Drawing, B Agrawal, CM Agrawal, TATA McGraw Hill
2. Engineering Drawing, P S Gill, S K Kataria & Sons
3. Engineering Drawing for Mechanical Trade, Instructional Material for Vocational Training, India
4. Automotive electrical and electronic systems, Tom Denton, Elsevier, third edition, 2004.
5. Elements of Mechanical Drafting, Samuel Yaslov, Delmar Publishers
6. Machine Drawing, N Sidhewar, P. Kannaiah, V.V.S. sastry, TaTa McGraw
7. Machine Drawing, P.S. Gill, Katsan Publishing House, Ludiana
8. A Text book of Engineering Drawing, R.B. Gupta, Satya Prakasan, Technical India
9. Mechanical Draughtsmanship, G.L. Tamta, Dhanpat Rai & Sons, Delhi
10. Geometrical and Machine Drawing, N.D. Bhatt, Cheroter book stalls, India
11. Engineering Drawing, D.N. Ghose, Dhanpat Rai & Sons, Delhi
12. Automotive Technology, W. Chrouse, MC Graw Hill Publication

# Control and Suspension System

**Total Class: 156 hrs.**

**Theory: 72 hrs.**

**Practical: 84 hrs.**

## Course Description:

This subject deals with basic hand tools, measuring instrument, power tools, basic principle of automobile system and their importance, function, working principle, types, trouble shooting and safety precautions related to control and suspension system and power trains in the automobile.

## Theory

1. **Chassis and Frame** **8 hrs.**
  - 1.1 Introduction and function and characteristics of chassis and Frame
  - 1.2 Types
    - The ladder frame
    - The cruciform frame
    - The perimeter frame
    - The sub frame
  - 1.3 The integral (Monocouqe) Body
  - 1.4 Body Dimensions : Overall length, width, height, Front overhang, rear overhang, Wheel base, angle of Approach and Angle of departure
  - 1.5 Body styles : Hatchback, Sedan, Coupe, Hardtop, Convertible, Pickup, Van, Wagon
  - 1.6 Nomenclature body parts: Bumper, Door, Pillar (A,B,C), Roof, Fender, Quarter pillar, hood, carrier assembly etc.
  - 1.7 Common defects in frame; methods of alignments of frame and methods for their repairing and straightening
  
2. **Axle** **8 hrs.**
  - 2.1 Definition of live and dead axle
  - 2.2 Definition, purpose and function of axle and hub.
  - 2.3 Types of stub/front axle
    - 2.3.1 Elliot stub axle
    - 2.3.2 Reversed elliot stub axle
    - 2.3.3 Lemoine stub axle
    - 2.3.4 CV joint
  
3. **Suspension System** **18 hrs.**
  - 3.1 Definition of the suspension system
  - 3.2 Types of spring
    - 3.2.1 Leaf spring
    - 3.2.2 Coil or helical spring
  - 3.3 Torsion bar
    - 3.3.1 Shock absorber and it's types
    - 3.3.2 Constructional features
    - 3.3.3 Trouble shooting.

- 3.4 Types of independent suspension system
  - 3.4.1 Parallelogram type
  - 3.4.2 Strut and link type/ McPherson strut
  - 3.4.3 Wishbone type
  - 3.4.4 Torsional spring type
- 3.5 Coil spring on upper control arm
  - 3.5.1 Types of rear suspension
  - 3.5.2 Leaf spring type
  - 3.5.3 Coil spring type
  - 3.5.4 Torsion bar
- 3.6 Air Suspension. Working principle and constructional details

#### 4. **Steering system.**

**20 hrs.**

- 4.1 Principle of Ackerman steering
- 4.2 Main components/parts of the steering system.
- 4.3 Introduction of steering gear.
- 4.4 Types of steering gear : Worm and roller steering gear, Re-circulating ball steering gear, Rack and pinion steering gear,
- 4.5 Necessity of lubricants in steering gear box.
- 4.6 Common troubles and remedies in steering gear box.
- 4.7 Introduction of front end geometry (steering geometry)
  - Camber
  - King pin inclination (steering axis)
  - Included angle
  - Caster
  - Toe-in
  - Toe-out on turns
  - Definition, purpose and importance of wheel alignment.
  - Definition, purpose and importance of wheel balancing.
- 4.8 Working principle of power steering
- 4.9 Purpose and importance of power steering
- 4.10 Types of power steering
  - Hydraulic
  - Electric
- 4.11 Component and function of Hydraulic power steering system
- 4.12 Component and function of Electric power steering system
- 4.13 Characteristics of hydraulic oil
- 4.14 Common troubles and their remedies on power steering.
- 4.15 Introduction of wheels and tyres.
- 4.16 Types of wheel
  - Disc wheel
  - Alloy wheel
- 4.17 Purpose and construction of tyre.
- 4.18 Tread pattern of tyre.
- 4.19 Types of tyre
  - Inner tube with tyre
  - Tubeless tyre

- 4.20 Types of tyre according to the ply
  - Bias or cross ply tyre
  - Radial ply tyre
- 4.21 Specification of tyre or tyre size and marking
- 4.22 Importance of inflating tyres to the correct pressure.
- 4.23 Purpose and methods of tyre rotation.
- 4.24 Trouble shooting on wheel and tyre.

## 5. Braking System

18 hrs.

- 5.1 Introduction of brake
- 5.2 Purpose of brake.
- 5.3 Principle of brake.
- 5.4 Types of brakes based on various aspects
  - 5.4.1 Based on purpose of application
    - Hand Brake or Parking brake
    - Foot brake or service brake
  - 5.4.2 Based on its construction
    - Drum brake (Expanding type brake)
    - Disc brake (Contracting type brake)
    - Drum in disc
  - 5.4.3 Based on mechanism or system used for power transfer
    - Mechanical brake system
    - Hydraulic brake system
    - Pneumatic Brake system
    - Air assisted hydraulic brake system
    - Electrical brake system
- 5.5 Purpose and method of brake adjustment
- 5.6 Function and construction of master cylinder
- 5.7 Types of master cylinder
  - 5.7.1 Single piston master cylinder
  - 5.7.2 Tandem master cylinder
  - 5.7.3 Stepped master cylinder
- 5.8 Purpose and function of wheel cylinder
- 5.9 Types of Wheel cylinder
  - 5.9.1 single acting
  - 5.9.2 double acting
- 5.10 Principle of hydraulic brake
- 5.11 Advantages and disadvantages of hydraulic brake
- 5.12 Properties of brake fluid
- 5.13 Purpose and procedure of brake bleeding
- 5.14 Types of disc brakes
  - 5.14.1 Floating caliper disc brake
  - 5.14.2 Sliding caliper disc brake
  - 5.14.3 Fixed caliper disc brake
- 5.15 Comparison or difference between various types of brake
- 5.16 Working principle of air brake system
- 5.17 Function of following air brake system components

- 5.17.1 Air compressor
- 5.17.2 Drying and distribution unit ( system protection valve, governor, unloader, purge tank)
- 5.17.3 Quick release valve
- 5.17.4 Auto load sensing valve
- 5.17.5 Relay
- 5.17.6 Pressure switches and gauges
- 5.17.7 Unloaded valve
- 5.17.8 Reservoir (air tank)
- 5.17.9 Brake chamber
- 5.17.10Slack adjuster
- 5.18 Working principle of Pneumatic brake with ABS
- 5.19 Purpose and function of mechanical brake or parking brake
- 5.20 Importance and function of brake booster
- 5.21 Working principle of Anti-lock Brake System (ABS)
- 5.22 Components of ABS
  - 5.22.1 Wheel speed sensor
  - 5.22.2 Hydraulic Modulator
  - 5.22.3 *Electronic control unit*

# **Control and Suspension System (Institute Based Practical)**

**Practical: 84 hrs.**

## **Course Description:**

The subject aims at imparting knowledge and skills to the student making them competent and potential in the field of repair and maintenance of suspension, brake, and steering system of automobile. The course is offered as hands on skills on repair and maintenance of automobile vehicles.

### **1. Suspension System**

- 1.1 Identify various units of vehicles.
- 1.2 Identify the defects in frame and body.
- 1.3 Overhaul front axle hub.
- 1.4 Overhaul Front Suspension.
- 1.5 Overhaul Leaf /coil /torsion springs.
- 1.6 Replace shock absorber and bushes.
- 1.7 Service/replace Steering Linkages.

### **2. Steering System**

#### **2.1 Mechanical system**

1. Identify different types of steering gear box
  - Worm and roller type
  - Recirculating ball
  - Rack and Pinion
2. Demonstrate the function of steering gear box
3. Dismantle different types of gear box
  - Worm and roller type
  - Recirculating ball
  - Rack and Pinion
4. Perform adjustment on steering system
  - Worm Shaft preloading
  - Backlash between sector shaft and rack piston
5. Troubleshoot mechanical steering system
6. Check /Rectify Wheel alignment & steering geometry.
7. Rectify Wheels, Tires and Steering Troubles.

#### **2.2 Power Steering System**

1. Identify the components of Hydraulic power steering system
2. Demonstrate the function of Hydraulic power steering system components
3. Draw a layout diagram of Hydraulic power steering system
4. Demonstrate working principal of Hydraulic power steering system
5. Dismantle power steering gear box/pump
6. Inspect various components of steering gear box/pump

7. Assemble of steering gear box/ pump
8. Perform steering Adjustment
  - Worm shaft preloading
  - Sector shaft backlash adjustment
9. Perform bleeding service on power steering system
10. Troubleshoot Hydraulic power steering system

### **2.3 Electric Power Steering System**

1. Identify the components of Electric power steering system
2. Demonstrate the function of Electric power steering system components
3. Draw a layout diagram of Electric power steering system
4. Remove and install electric power steering column from Vehicle
5. Demonstrate working principal of Electric power steering system
6. Use Diagnostic scanner to check data related with EPS
7. Troubleshoot power steering system

## **3. Brake System**

### **3.1 Hydraulic Brake System**

1. Familiarize with safety precaution.
2. Locate/identify different component of brake system.
3. Demonstrate the function of hydraulic brake system components
4. Draw a layout diagram of braking system
5. Dismantle flowing braking system components
  - Master Cylinder
  - Wheel Cylinder
  - Vacuum Assisted brake booster
  - Brake Caliper
6. Inspect hydraulic braking system components
7. Demonstrate operating principle of braking system
8. Assemble braking system components
9. Remove/refit brake shoes/caliper disc and brake pad
10. Adjust shoe to drum clearance
11. Bleed brake system
12. Adjust parking brake
13. Adjust brake pedal free play
14. Troubleshooting of brake system

### **3.2 Anti-Lock Braking System (ABS)**

1. Identify components of Anti-lock braking system (ABS)
2. Demonstrate the function of ABS Components
3. Draw a layout diagram of Anti-lock Braking system
4. Demonstrate the operation of ABS

5. Draw antilock braking system circuit diagram
6. Remove Anti-Lock Braking System components from the vehicle
7. List out specification of Anti-Lock Braking system
8. Inspect ABS Components
9. Install ABS system components on vehicle
10. Check voltage, continuity short circuit in the system
11. Check resistance of ABS components
12. Perform workshop test using diagnostic tool
  - Multimeter
  - Diagnostic tool

### **3.3 Pneumatic Brake System**

1. Familiarize with Workshop Safety
2. Draw a layout diagram of 'S' cam full air brake system
3. Identify different air brake system components
4. Demonstrate the function of following air brake system components
  - Air compressor,
  - Dry and Distribution Unit, (system protection valve, air dryer, unloader, safety valve)
  - Service Air Tanks
  - Dual Brake Valve
  - Air Brake chamber Front
  - Spring Brake Actuator Rear
  - Slack Adjusters
  - Graduated Hand Brake Valve
  - Quick Release Valve
  - Automatic Load Sensing Valve
  - Engine Exhaust Brake Solenoid Valve
  - Mechanical Stop Light Switch
  - Isolator Switch Exhaust Brake
5. Demonstrate the function of following electrical Indicators/Gauges in Air Brake system
  - Low Air Pressure indicator
  - Hand Brake Indicator (Red) and Beeper
  - Air Pressure Gauges
  - Engine Exhaust Brake Indicator
6. Identify port on air braking system
7. Dismantle and demonstrate working principle of air brake components
  - Air compressor,
  - Dry and distribution unit
  - Dual brake valve,
  - Air brake chamber front
  - Spring brake actuators rear
  - Slack adjusters, hand brake valve

- Brake shoes and S cam shaft
  - Air Compressor,
  - dry and distribution unit,
  - dual brake valve,
  - air brake chamber front
  - spring brake actuators rear,
  - slack adjusters
  - hand brake valve
  - Quick release valve and automatic load sensing valve
8. Inspect of air brake components.
  9. Assemble following air brake components
    - Air Compressor
    - dry and distribution unit
    - air brake chamber front
    - spring brake actuators rear
    - slack adjusters
    - hand brake valve
    - brake shoes and S cam shaft
  10. Follow standard brake adjustment procedure
  11. Perform brake system routine check and service
  12. Perform brake system diagnosis

# Power Train

**Total Class: 156 hrs.**

**Theory: 72 hrs.**

**Practical: 84 hrs.**

## Course Description:

The subject aims at imparting knowledge and skills to the student making them competent and potential in the field of repair and maintenance of clutch, gearbox, axle and final drive unit of power train system of automobile. The course is offered as hands on skills on repair and maintenance of automobile vehicles.

## Theory

**72 hrs**

### 1. Transmission

**6 hrs.**

- Need of transmission system in a vehicle
- Different layout of the power transmission in a vehicle

### 2. Clutch

**10 hrs.**

- Necessity for a clutch in a vehicle
- Function of the clutch
- Layout of clutch
- Types of clutch used in vehicle
- Function of clutch components
- Various types of clutch actuation system
- Operation of mechanically operated clutch
- Operation of hydraulically operated clutch
- Function and operating principle of fluid clutch and torque converter.
- Trouble shooting of clutch

### 3. Gearbox

**20 hrs.**

- Necessity of a gear box in a vehicle
- Different types of gear boxes
  - Function of components of sliding mess gearbox
  - Working principle of sliding mesh gear box
- Function of components of constant mess gearbox
- Working principle of constant mesh gear box.
- Function of components of synchromesh gearbox
- Working principle of synchromesh gear box
- Advantages and disadvantages of different types of gear box
- Different types of gear
- Epicyclic gear mechanism
- Introduction to automatic transmission
- Working principle of automated manual transmission.
- Double clutch transmission and its working principle
- Trouble shooting of gearbox

- 4. Gear shifting mechanism** **6 hrs.**
- Various types of gear shift mechanism
  - Working principle of gear shift mechanism
  - Trouble shooting of gear shifting
- 5. Propeller shaft, Universal Joint and Slip Joint** **6 hrs.**
- Function of the propeller
  - Purpose of center bearing,
  - Trouble shooting related to propeller shaft
  - Purpose and function of a universal joint
  - Various types of universal joint and its construction
  - Purpose and function of a slip joint
  - Introduction of hotchkiss drive
  - Introduction of torque tube drive
  - Trouble shooting
- 6. Rear Axle Assembly** **6 hrs.**
- Various types of axle housings
  - Various types of rear axles
  - Merits and demerits of each types of the rear axle
  - Trouble shooting related to rear axle
- 7. Final drive** **10 hrs.**
- Introduction to transaxle
  - Purpose, function and types of differential
  - Constructional features of differential
  - Operating principle of differential.
  - Limited slip differential
  - Differential adjustments
  - Trouble shooting
- 8. Four wheels drive and Transfer case** **8 hrs.**
- Difference between two wheel drive and four wheel drive
  - Purpose and function of transfer case
  - Types of transfer cases
  - Operating principle of transfer cases.
  - Trouble shooting on four wheel drive

## **Power Train (Institute Based Practical)**

**Practical: 84 hrs**

- 1. Clutch** **12 Hrs**
- 1.1 Familiarize with workshop safety
  - 1.2 Identify various clutch components
  - 1.3 Demonstrate clutch operation
  - 1.4 Demonstrate the function of clutch and their components
  - 1.5 Demonstrate use of special service tools
  - 1.6 Perform dismantling, operating Principle, Inspection & Assembly of:
    - Clutch Master Cylinder
    - Clutch Slave Cylinder
  - 1.7 Adjust clutch pedal free play
  - 1.8 Perform dismantling, inspection & assembly of pressure plate
  - 1.9 Inspect clutch wears
  - 1.10 Adjust pressure plate release levers height
  - 1.11 Familiarize with Do's and Don'ts on clutch
  - 1.12 Trouble shoot on clutch
- 2. Gear Box** **30 Hrs**
- 2.1 Familiarize with workshop safety
  - 2.2 Demonstrate use of special service tools.
  - 2.3 Remove gear box from vehicle and dismantle it
  - 2.4 Perform disassembly of :
    - Drive shaft
    - Main shaft
    - Counter shaft
    - Rear cover
    - Front cover
    - Top cover
  - 2.5 Identify various gear box components
  - 2.6 Demonstrate the function of gear box components
  - 2.7 Demonstrate the operation of gear box
  - 2.8 Inspect gear box components
  - 2.9 Familiarize with technical specification based on model, type, gear ratio, tightening torques, lubrication and maintenance)
  - 2.10 Determine the selection of spacer
  - 2.11 Determine the selection of shims for drive shaft main shaft and counter shaft.
  - 2.12 Perform assembly of :
    - Drive shaft

- Main shaft
- Counter shaft
- Rear cover
- Front cover
- Top cover

2.13 Assemble gear box

2.14 Trouble shoot on gear box

### **3. Transfer Case 10 Hrs**

3.1 Dismantle transfer case

3.2 Identify transfer case components.

3.3 Demonstrate function of transfer case components.

3.4 Demonstrate the operation of transfer case.

3.5 Inspect the transfer case components.

3.6 Assemble transfer case.

3.7 Trouble shoots on transfer case.

### **4. Rear Axle and final drive unit 20 Hrs**

4.1 Familiarize with workshop safety

4.2 Identify various components of rear Axle

4.3 Demonstrate the function of rear axle components

4.4 Demonstrate use of special service tools

4.5 Remove hub from rear axle tube

4.6 Dismantle hub

4.7 Inspect the components

4.8 Install hub on rear axle tube

4.9 Check and adjust hub bearing play

4.10 Remove, inspect and refit propeller shaft.

4.11 Remove replace universal joints and slip joints

4.12 Remove/detach crown wheel, differential and tail pinion assembly from carrier housing

4.13 Dismantle differential

4.14 Identify differential components

4.15 Demonstrate operation of differential

4.16 Demonstrate the function of differential components

4.17 Inspect the differential components

4.18 Assemble tail pinion.

- Check and adjust frictional movement of tail pinion bearings
- Check tail pinion depth

4.19 Assemble differential

- Check and adjust differential bevel gears back lash
- Check and adjust back lash between tail pinion and crown wheel

- Adjust gap between crown and thrust pad
- 4.20 Trouble shoot on differential

## **5. Transaxle**

**12 Hrs**

- 5.1 Remove transaxle from the vehicle.
- 5.2 Demonstrate use of special service tools.
- 5.3 Dismantle transaxle.
- 5.4 Identify transaxle components.
- 5.5 Demonstrate function of transaxle components.
- 5.6 Demonstrate operation of transaxle.
- 5.7 Inspect transaxle components.
- 5.8 Demonstrate tail pinion bearing pre loading, tail pinion depth and back lash adjustment between tail pinion and ring gear.
- 5.9 Assemble the Transaxle.
- 5.10 Trouble on Transaxle.

*Note: Related safety precaution should provide while performing the task.*

# Automotive Engine

**Total: 156 hrs.**  
**Theory: 72 hrs.**  
**Practical: 84 hrs.**

## Course Description:

This subject deals with basic hand tools, measuring instrument, power tools, basic principle of automobile system and their importance, function, working principle, types, trouble shooting and safety precautions related to control and suspension system and power trains in the automobile.

## Theory

**72 hrs.**

### A. Automobile engine

#### 1. Engine

**12 hrs.**

- 1.1. Introduction, history and development of automobile and engine
- 1.2. Various types of automobile : 2 wheeler, 3 wheeler, passenger, commercial, special application vehicles
- 1.3. Terminologies related to the automobile engine: Bore , Stroke, TDC, BDC
- 1.4. Two stroke and four stroke cycle engine.
- 1.5. Principle of internal combustion engine.
  - Spark ignition engine.
  - Compression ignition engine.
- 1.6. Overview and Concept of Eco friendly vehicles : Hybrid Electric Vehicles, Plug in hybrid electrical vehicle and Fuel cell electric vehicles (FCEV)
- 1.7. Types of engine based on construction
- 1.8. Function and types of combustion chamber.

#### 2. Valve and valve mechanism

**5 hrs.**

- 2.1. Functions
- 2.2. Construction
- 2.3. Operating mechanism.
  - Side valve mechanism
  - Overhead valve mechanism
  - Overhead camshaft mechanism
- 2.4. Importance of valve timing and valve clearance.
- 2.5. Valve timing diagram & valve overlap
- 2.6. Variable valve timing (VVT)
- 2.7. Hydraulic latch adjuster (HLA)
- 2.8. Trouble shooting.

#### 3. Piston and piston rings.

**4 hrs.**

- 3.1. Function of piston
- 3.2. Construction & types of piston
- 3.3. Function of piston rings.
- 3.4. Construction and types of piston rings
- 3.5. Piston ring gap & side play, clearance

- 3.6. Trouble shooting.
- 4. Connecting rod, piston pin, and crankshaft** **4 hrs.**
- 4.1. Function of connecting rod
  - 4.2. Construction of connecting rod.
  - 4.3. Function of piston pin.
  - 4.4. Function of crankshaft.
  - 4.5. Construction of crankshaft
  - 4.6. Construction of main and connecting rod bearing/shells.
  - 4.7. Measurement of Bore diameter, Ovality, taperness etc....
  - 4.8. Balance Shaft Module/balancer
  - 4.9. Trouble shooting.
- 5. Flywheel** **2 hrs.**
- 5.1. Function and construction of flywheel.
  - 5.2. Significance of the timing mark on the flywheels.
- 6. Vibration damper.** **2 hrs.**
- 6.1. Purpose of vibration damper
  - 6.2. Following types of vibration damper
    - Rubber type vibration damper.
    - Friction - type vibration damper
    - Fluid - type vibration damper
- 7. Camshaft** **2 hrs.**
- 7.1. Function of camshaft.
  - 7.2. Construction of camshaft.
  - 7.3. Types of drive mechanism.
    - Camshaft gear drive
    - Camshaft chain or sprockets drive
    - Camshaft toothed pulley and belt drive
    - Single overhead (SOHC) and double overhead camshaft (DOHC)
  - 7.4. Trouble shooting.
- 8. Cooling system** **6 hrs.**
- 8.1. Operation of the cooling system
  - 8.2. Types of cooling system.
    - Direct air cooling system
    - Indirect or liquid (coolant) cooling system
      - Thermo siphon system
      - Pump circulation system
  - 8.3. Components of cooling system.
    - Radiator (tube and fins type, film type, air tube type)
    - Water pump (impeller type, centrifugal type)
    - Fan (belt drive, electric drive, viscous)
    - Thermostat (bellows - type and wax - element type)
    - Thermo time switch
  - 8.4. Function of radiator cap.

- 8.5. Water jacket
- 8.6. Coolant , its grades
- 8.7. Trouble shooting

## **9. Lubricating system**

**5 hrs.**

- 9.1. Working principle of lubrication system.
- 9.2. Function of engine oil.
- 9.3. Properties of engine oil
- 9.4. Viscosity rating or grades of oil
  - API
  - SAE
- 9.5. Viscosity index (VI)
- 9.6. Reasons for using engine oil additives
  - Film strength agents
  - Oxidation inhibitors.
  - Corrosion and rust inhibitors
  - Forming resistance
  - Extreme - pressure resistance
- 9.7. Types of lubrication system.
  - Splash lubrication system
  - Pressure lubrication system
- 9.8. Main parts of lubrication system.
  - Oil sump or oil pan (dry and wet sump)
  - Oil pump (gear pump, rotor pump, plunger pump, vane type pump, variable pressure oil pump)
  - Pressure relief valve and filter bypass valve
  - Oil filter
  - Oil gallery
  - Oil cooler
- 9.9. Types of filtration system.
  - By pass system
  - Full flow system
- 9.10. Function of oil pressure indicator
- 9.11. Function of crankcase ventilation system
- 9.12. Trouble shooting of lubricating system.

## **10. Air intake and exhaust system**

**8 hrs.**

- 10.1. Function of air cleaner
- 10.2. Types of air cleaner
  - Dry type air cleaner
  - Oil bath type air cleaner
  - Thermostatically controlled air cleaner
- 10.3. Function and construction of exhaust manifold, exhaust pipe, and muffler.
- 10.4. Intake manifold
- 10.5. Variable intake system (VIS) and Swirl control Valve System (SCV)
- 10.6. Turbo charger & supercharger.
  - Waste gate turbocharger (WGT)

- Variable geometry turbocharger (VGT) and EVGT
- Concept of turbo lag, volumetric efficiency, intercooler

### **11. Petrol fuel system**

**10 hrs.**

- 1.1. Purpose and function of petrol fuel system
- 1.2. Main parts of the petrol fuel system
  - Fuel tank
  - Fuel pipe line of filter
  - Fuel pump (mechanical and electrical fuel pump)
  - FUEL injector
- 1.3. Purpose, function and working principle of carburetor
- 1.4. Trouble shooting.

### **12. Diesel fuel system**

**12 hrs.**

- 12.1. Purpose and function
- 12.2. Main parts of the diesel fuel feed system
  - Fuel tank
  - Fuel lines
  - Pre – filter
  - Water separator
  - Fuel filter
  - Fuel feed pump or transfer pump
  - Injectors
- 12.3. Function and types of diesel fuel filter
- 12.4. Function and construction of fuel feed/transfer pump
- 12.5. Function, operating principle and types of injection pump: in line and rotary pump
- 12.6. Function and types of fuel injector.
- 12.7. Trouble shooting.

## **Automotive Engine (Institute Based Practical)**

**Practical: 84 hrs**

### **Course Description:**

The subject aims at imparting knowledge and skills to the student making them competent and potential in the field of repair and maintenance of petrol and diesel engine. The course is offered as hands on skills on repair and maintenance of automobile engines.

### **Perform the following activities**

1. Familiarize with workshop safety
2. Handle special tools
3. Demonstrate operating principle of engine
4. Overhaul/dismantle of various engine
  - Disassembly of Head
  - Disassembly of Block
5. Identify various engine components
6. Demonstrate function of engine components
7. Demonstrate operating principle, repair and maintenance of following systems in engine
  - Air induction system
  - Exhaust system
  - Cooling system
  - Lubricating system
  - Fuel system
  - Charging system
  - Starting system
8. Practice reading on Vernier Caliper, Cylinder bore gauge, inside micrometer, outside micrometer
9. Measure engine components
  - Measurement of ovality and taperness
    - Cylinder bore
    - Crankshaft main journal and big end journal
  - Pistons
  - Main bearings parent bores with bearings
  - Big end bearing parent bores with bearings
  - Cam shaft journals
  - Cam bushes in cylinder block
10. Inspect various engine components
11. Assemble the engine
  - Assemble of engine block
  - Assembly of engine head

12. Set valve timing

- Gear drive
- Chain drive
- Belt drive

13. Tighten cylinder head bolt with specified torque in sequence

14. Set fuel injection pump timing

15. Adjust valve clearance

- Calculate of shim size to get specified valve clearance in overhead camshaft
- Perform cylinder compression/pressure test
- perform oil pressure tests
- Perform emission test using smoke analyzer

16. Troubleshoot of engine

# Auto Electrical and Electronics System

**Total: 156 hrs.**  
**Theory: 72 hrs.**  
**Practical: 84 hrs.**

## Course Description:

The subject aims at imparting knowledge and skills to the student making them competent and potential in the field of repair, maintenance and troubleshoot of auto electrical and electronics system. The course is offered as hands on skills on repair and maintenance of automobile electrical and electronics system.

## Theory

**72 hrs.**

### A. Basic Electrical

#### 1. Automobile electrical/electronics

**4 hrs.**

- 1.1. Concept of current, voltage and resistance
- 1.2. Direct and alternating currents
- 1.3. Ohms Law
- 1.4. Measuring instruments:-
  - Ammeter
  - Voltmeter
  - Ohmmeter
- 1.5. Simple electric circuit
  - Series circuit
  - Parallel circuit
  - Open circuit
  - Short circuit
  - Combined Circuit
- 1.6. Insulators and conductors
- 1.7. Basic electronic components diode, switch, transistor, resistor, capacitor, inductor fuse, relay, rectifier etc.
- 1.8. Electrical symbols and color code used in automobile.
- 1.9. Sketch of Simple electric circuit diagram
- 1.10. Electrical Circuit diagram
- 1.11. Component locations, connector view and Harness layout
- 1.12. Electrical symbols used in automobile.
- 1.13. Relation between cable sizes and current carryings capacity of cables.

#### 2. Automobile Battery

**4 hrs.**

- 2.1. Introduce the battery
- 2.2. Cell and plates
- 2.3. Electrolyte.
- 2.4. Construction of battery
  - Plates
  - Cell elements
  - Cell covers

- Cell connector
- 2.5. Chemical action during discharging and charging
- 2.6. General maintenance of battery
- 2.7. Methods of battery charging
  - Slow charge method
  - Quick charge method
  - Trickle charge method
- 2.8. Testing methods of charged battery
  - Specific gravity test
  - High rate discharge test
  - Voltage test

## **B. Engine Electrical**

### **3. Ignition system**

**6 hrs.**

- 3.1. Define the ignition system
- 3.2. Function of ignition system.
- 3.3. Components of ignition system.
  - Ignition coil
  - Condenser
  - Distributor
  - Spark plug
- 3.4. Operating principle of Battery point ignition system.
  - Ignition circuits
    - Primary
    - Secondary
- 3.5. Electronic ignition system.
  - Hall
  - Induction
- 3.6. Distributor less Ignition System
- 3.7. Identify the causes and their remedies ignition system.

### **4. Charging system**

**6 hrs.**

- 4.1. Function of charging system
- 4.2. Charging circuits
- 4.3 Introduction to alternator
- 4.4 Basic principle of alternator
- 4.5 Basic construction of alternator
  - Rotor assembly
  - Stator assembly
  - Diodes
- 4.6 Types of alternator regulator
- 4.7 Identify the causes and their remedies of the charging system.

### **5. Starting system**

**6 hrs.**

- 5.1 Introduction to starting system
- 5.2 Function of starter motor

- 5.3 Starter motor controls and circuits.
- 5.4 Starter motor drives
- 5.5 Types of starter motor drives
  - Bendix drive
  - Over running clutch drive
  - Reduction gear starter motor
- 5.6 Function and construction of the solenoid switch
- 5.7 Trouble shooting of starting system

**C. Engine management system (EMS)**

**6. Electronic diesel control system**

**4 hrs.**

- 6.1 Introduction to electronic diesel control system (EDC)
- 6.2 Advantage of electronic diesel control system
- 6.3 Block diagram of electronic diesel control system
- 6.4 Fuel System layout of EDC
- 6.5 Function and operation of EDC system components
  - Sensors
  - Electronic control unit ( ECU)
  - Actuators
- 6.6 Circuit diagram of electronic diesel control system
- 6.7 Troubleshooting of EDC system

**7. Direct injection common rail System**

**12 hrs.**

- 7.1 Introduction to direct injection common rail system
- 7.2 Advantage of direct injection common rail system
- 7.3 Block diagram of direct injection common rail system
- 7.4 Fuel system layout of CRDI system
- 7.5 Function and operation of CRDI system components
  - Sensors
  - Electronic control unit ( ECU)
  - Actuators
- 7.6 Circuit diagram of direct injection common rail system
- 7.7 Troubleshooting of direct injection common rail system

**8. Multi point fuel injection system (MPFI)**

**12 hrs.**

- 8.1 Introduction to multi point fuel injection system
- 8.2 Advantage of multi point fuel injection system
- 8.3 Block Diagram of multi point fuel injection system
- 8.4 Fuel system layout of multi point fuel injection system
- 8.5 Function and operation of multi point fuel injection system components
  - Sensors
  - Electronic control unit ( ECU)
  - Actuators
- 8.6 Circuit Diagram of multi point fuel injection system
- 8.7 Troubleshooting of multi point fuel injection system

## **9. Emission Control System**

**2 hrs.**

- 9.1 Overview of emission control system.
- 9.2 Components/devices used to control pollution.
- 9.3 Trouble shooting.

## **D. Body Electrical**

### **10. Lighting System**

**16 hrs.**

- 10.1 Purpose and operation of the exterior and interior lights: Head light, Reverse light, Park, tail and number plate light, Stop light, Turn signal light/hazard light, Fog light, Room Lamp.
- 10.2 Purpose and operation of Indicators and Gauges used on the car : Dash lights, Engine oil pressure indicator, Engine coolant temperature indicator, Charging indicator, Fuel gauge, Speedometer, Brake failure warning light, Turn signal indicator, High beam warning light, Park brake "on" indicator, The window demister "ON" indicator, The tachometer or clock
- 10.3 Purpose and operation of Horn System
- 10.4 Purpose and operation of multifunction switch
- 10.5 Windscreen wipers , washers and defogger system
- 10.6 Power window System
- 10.7 Power door lock and mirror, Center locking system
- 10.8 Immobilizer and push button start system
- 10.9 Heating ventilation and Air Conditioning System
- 10.10 Airbag System
- 10.11 Auxiliary Equipment : Cigarette lighter, Clock, Audio/AVN System, Fog light
- 10.12 Trouble shooting of Body electrical Systems.

## **Auto Electrical and Electronics System**

(Institute Based Practical)

**Practical: 84 hrs.**

### **Course Description:**

The subject aims at imparting knowledge and skills to the student making them competent and potential in the field of repair, maintenance and troubleshoot of auto electrical and electronics system. The course is offered as hands on skills on repair and maintenance of automobile electrical and electronics system.

### **Perform the Following Activities**

1. Service/charge/test battery
2. Service/repair/testing of charging system
3. Service/repair/testing of starting system
4. Service/repair/testing of lighting system and auxiliary equipment
5. Service, repair and replace fuse, fusible link, circuit breaker switch and relays
6. Service/repair /testing of distributor type ignition system with C.B. point
7. Service/repair /testing of distributor-less ignition system
8. Troubleshoot engine management system( EMS)
9. Troubleshooting electrical diesel control system (EDC) and CRDI
10. Service/repair and test of immobilizer control unit
11. Service/repair/replace power window winding
12. Service/repair of center locking system
13. Remove/replace/testing of Body Control Module (BCM)

# Automobile Body Shop Repair

**Total: 114 hrs.**  
**Theory: 42 hrs.**  
**Practical: 72 hrs**

## Course Description:

This course is designed to impart knowledge and skills on automobile body shop repair systems used in automobile engineering.

## Course Objectives:

After the completing this course the students will be able to:

- Analyze automotive structural damage and repair requirements.
- Analyze automotive non-structural damage and repair requirements.
- Diagnose and repair collision damaged mechanical and electrical components.
- Demonstrate automobile painting and refinishing skills.
- Demonstrate safe working habits and procedures within an auto collision/repair facility.

## Course content:

### **Unit 1: Understanding elements involved with auto body repair and paint**      **2T + 2Phrs**

- 1.1. Define and discuss what makes collision repair necessary
- 1.2. Design and discuss a body shop layout
- 1.3. Discuss auto body personnel and what function they serve in a body shop
- 1.4. Find the variables necessary to write an accurate collision damage estimate

### **Unit 2: Paint and body shop safety (BASIC FIRST AID)**      **2T+2Phrs**

- 2.1 Discuss personal safety (respiration, safety glasses, and welding helmet, etc.)
- 2.2 Discuss proper dress (boots, no loose clothing or jewelry, tie hair, etc.)
- 2.3 Know all shop safety rules
- 2.4 Discuss and demonstrate basic first aid
- 2.5 Paint safety training (Online)
- 2.6 Shop safety training (Online)
- 2.7 Environmental pollution prevention

### **Unit 3: General hand tools (USE & IDENTIFICATION)**      **2T+2Phrs**

- 3.1 Discuss and demonstrate use of various hand tools
- 3.2 Discuss safe use of hand tools

### **Unit 4: Power tools (USE & IDENTIFICATION)**      **3T+3Phrs**

- 1.1 Discuss and demonstrate use of various power tools
- 1.2 Discuss safe use of power tools

### **Unit 5: Introduction to welding and cutting**      **3T+7Phrs**

- 5.1 Demonstrate use of MIG welder, Oxy Acetylene Gas welding and discuss technique and types of welds

<b>Unit 6: Metal working</b>	<b>3T+8hrs</b>
6.1. Understand different metal straightening techniques	
a. Rough out	
b. Kinking	
c. Cold shrinking	
d. Heat shrinking	
e. Finishing	
f. Identify when panel should be repaired or replaced	
<b>Unit 7: Body fillers (PLASTIC &amp; FIBERGLASS FILLERS)</b>	<b>3T+6Phrs</b>
7.1 Discuss and demonstrate use and application	
7.2 Determine when to use waterproof fillers	
<b>Unit 8: Surface preparation</b>	<b>3T+6Phrs</b>
8.1 Evaluate grit-rating chart	
8.2 Determine method of preparation for specific substrate	
8.3 Discuss metal conditioners and adhesion promoters	
8.4 Discuss solvent cleaners	
<b>Unit 9: Masking for Custom Painting</b>	<b>3T+5Phrs</b>
9.1 Identify and discuss types of masking tapes and proper use (fine line, dart, etc.)	
9.2 Identify and discuss types of masking paper and plastic sheeting	
9.3 Discuss and demonstrate masking techniques (back & reverse masking)	
<b>Unit 10: Math and Measuring Sketching a design</b>	<b>2T+2Phrs</b>
10.1 Discuss and demonstrate how to use a tape measure	
10.2 Determine how ratios, percentages and fractions relate to auto body repair	
10.3 Basic math review and exercises	
<b>Unit 11: Mixing and applying undercoats</b>	<b>3T+5Phrs</b>
11.1 Discuss importance of undercoats	
11.2 Determine proper undercoat for specific substrate	
11.3 Discuss mixing and application technique for undercoats	
11.4 Discuss how the substrate determines type of undercoat to be used	
<b>Unit 12: Mixing and applying topcoats</b>	<b>3T+5P hrs</b>
12.1 Discuss purpose and characteristics of topcoats	
12.2 Examine types of topcoats (single stage, basecoat, clear coat and multi-stage)	
12.3 Discuss and demonstrate mixing and application and topcoats	
<b>Unit 13: Refinishing equipment</b>	<b>2T+4Phrs</b>
13.1 Examine types of spray equipment (gravity, suction and pressure feed)	
13.2 Identify spray gun components and demonstrate spray techniques	

**Unit 14: Auto construction** **3T+4Phrs**

14.1 Discuss types of materials used in vehicle construction

14.2 Examine vehicle construction (body-over-frame, unibody, space frame)

14.3 Identify auto body parts. Proper nomenclature

**Unit 15: Fasteners** **2T+4Phrs**

15.1 Discuss how fasteners hold a vehicle together

15.2 Determine types of fasteners used in vehicle construction (nuts, bolts, screws, etc.)

15.3 Bolts terminology (bolt strengths or grades)

**Unit 16: Automotive detailing** **2T+4Phrs**

16.1 Discuss the importance of auto detailing

16.2 Identify methods to clean paint surfaces

16.3. Identify methods to clean glass

16.4 Identify methods to clean interior, carpet, upholstery, etc.

**Unit 17: Internet Research for Collision Repair** **1T + 3Phrs**

17.1 Dealer sites

17.2 Insurance sites

17.3 Parts Search

17.4 Identify and use Refinish Material web sites

17.5 Repair techniques at auto body

**Reference Books:**

1. Motor Auto Body Repair Third Edition, Delmar Publishing.
2. Complete Automotive Painting, Delmar Publishing
3. Collision Repair 2000, Units 1-4 & 5-8, I-CAR (Inter-Industry Conference On Auto Collision Repair)
4. Finish Matching, Restoring Pre-Accident Appearance, Parts 1 & 2, I-CAR (Inter-Industry Conference On Auto Collision Repair)
5. THE ART OF REFINISHING, Standox Technical Data Guide, February 1998 Edition

# Applied Mathematics

**Total: 75 hrs.**  
**Theory: 75 hrs.**

## **Description:**

This subject consists of basic mathematical calculation of work, energy and power, force, speed, velocity and related to automobile engineering students to develop mathematical background helpful for auto mechanical engineering works.

<b>Areas and topics</b>	<b>Time (hrs.)</b>
<b>1. SI units/conversion factors</b>	<b>3 hrs.</b>
1.1. Basic units	
1.2. Derived SI units and relationship	
1.3. Decimal, multiples and parts of units	
1.4. Example and exercises	
<b>2. Other system of units (FPS system, CGS system, Metric system)</b>	<b>3 hrs.</b>
2.1. Conversion and comparative table of previous technical units and SI units	
2.2. Conversion of Length units	
2.3. Example and exercises	
<b>3. Fractions</b>	<b>2 hrs.</b>
3.1. Concept and value of a fraction	
3.2. Multiplication	
3.3. Division	
3.4. Addition	
3.5. Subtraction	
3.6. Example and exercises	
<b>4. Percentage</b>	<b>2 hrs.</b>
4.1. Conversion of the percentage into actual number	
4.2. Conversion of the real number into percentage	
4.3. Example and exercises	
<b>5. Circumferences</b>	<b>2 hrs.</b>
5.1. Definition of circumference	
5.2. Circumference	
5.3. Sector	
5.4. Polygons	
5.5. Examples and exercises	
<b>6. Pythagoras' Theorem</b>	<b>2 hrs.</b>
6.1. Terms used in Pythagoras' theorem	
6.2. Pythagoras formula	
6.3. Summary	
6.4. Examples and exercises	
<b>7. Unitary method</b>	<b>2 hrs.</b>

- 7.1. Concept of unitary method
- 7.2. Variance and types
- 7.3. Chain rule
- 7.4. Estimate time, money and number of worker for any job
- 7.5. Examples and exercise

**8. Introduction to Earning Interest:**

- 8.1. Principal **2 hrs.**
- 8.2. Deposit
- 8.3. Interest
- 8.4. Annual percentage rate(APR)
- 8.5. Compounding Period, annual compounding , quarterly compounding

**9. Area of regular quadrilaterals**

- 9.1. Square **2 hrs.**
- 9.2. Rhombus
- 9.3. Rectangle
- 9.4. Parallelogram
- 9.5. Examples and exercises

**10. Area of other shapes**

- 10.1. Triangle **3 hrs.**
- 10.2. Trapezium
- 10.3. Circle
- 10.4. Sector
- 10.5. Circular ring
- 10.6. Examples and exercises

**11. Volume of prismatic bodies**

- 11.1. Concept of cube, prism and cylinder **3 hrs.**
- 11.2. Cube
- 11.3. Prism
- 11.4. Cylinder
- 11.5. Engine Capacity calculations
- 11.6. Examples and exercises

**12. Mass**

- 12.1. Concept of mass and density **2 hrs.**
- 12.2. Mass
- 12.3. Density
- 12.4. Examples and exercises

**13. Weight and force**

- 13.1. Concept of weight and force **2 hrs.**
- 13.2. Weight
- 13.3. Force

<b>14. Uniform speeds</b>	<b>6 hrs.</b>
14.1. Laws of motion	
14.2. Velocity in straight line, circular path	
14.3. Acceleration	
14.4. Examples & exercises	
<b>15. Average speed</b>	<b>4 hrs.</b>
15.1. Stroke speed	
15.2. Piston speed	
15.3. Examples & exercises	
<b>16. Work, power and efficiency</b>	<b>6 hrs.</b>
16.1. Work	
16.2. Power	
16.3. Efficiency	
16.4. Examples & exercises	
<b>17. Effects of force calculation</b>	<b>6 hrs.</b>
17.1. Representation	
17.2. Line of application	
17.3. Equi-directional force	
17.4. Opposite forces	
17.5. Force at an angle	
17.6. Resolution of forces	
17.7. Supports reaction	
17.8. Equilibrium	
17.9. Examples & exercises	
<b>18. Gear drive calculation</b>	<b>12 hrs.</b>
18.1. Dependency of pitch diameter and revolution	
18.2. Transmission ratio	
18.3. Distance between axis	
18.4. Multiple (compound) gear drive calculation	
18.5. Examples & exercises	
<b>19. Engine capacity calculation</b>	<b>6 hrs.</b>
19.1. Clearance volume	
19.2. Swept volume	
19.3. Engine capacity	
19.4. Piston displacement	
19.5. Torque calculation, IHP, BHP, FP	
19.6. Examples & exercises	

**References:**

1. G.S. Sethi, K. Kakkar, Workshop calculation and science, Tata McGraw-Hill Publishing company Limited New Delhi
2. H.P. Dahal ,*United's Math in action grade-10* ,United Nepal publication
3. R Awasthi, B.H. Subedi, B. B. Subedi, *UNIQUE Mathematics book-9*, Unique Educational Publishers Pvt. Ltd.
4. Technical Mathematics book for metal Trade, GTZ
5. G. Hamm. G. Burk, *Tables for the Automobile Trade*, Special edition for the Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ), Wiley Estern Limited, New Delhi, India

## Applied Communication and Professionalism

**Total Time: 90 hours**

**Lecture: 60 hours**

**Practical: 30 hours**

### Course Description:

This course is designed for the development of communication skill in Nepal and English language and enhances student professional skill in working places. The communication skill focus on English and Nepali language communication skills specially in speaking for to-be professional technicians of Nepal who will work in national and international labor market after completing the professional course in their respective sector from the Technical Training Center /Institutes. Professional development course enhancing professional development through self-motivation, positive attitudes, decision making skill, creativity skill, stress and time management knowledge, team work and leadership skill in a student life and professional careers.

### Course Objective:

After the completion of this course the students will be able to:

- Communicate on relevant day to day activities
- Sharpen their speaking and writing skills in English and Nepali Language.
- Impart relevant knowledge on self-motivation, creativity and positive thinking.
- Explain importance, influence and methods of managing time and stress.
- Follow decision making process, team building and leadership to the efficient organizational functioning.

### Course Contents (Theory):

**60 hrs**

Units	Topics	Contents	Hours
<b>1</b>	<b>Communicative functions/ Conversation skills</b>		<b>12 hrs</b>
		<b>1.1 Everyday functions:</b> 1.1.1 Greetings, 1.1.2 Welcoming, 1.1.3 Introductions, 1.1.4 Thanking, 1.1.5 Excuses/apologizing/forgiving	3
		<b>1.2 Everyday Activities:</b> 1.2.1 Asking about activity 1.2.2 Asking about trouble/problems/conditions 1.2.3 Asking about health status 1.2.4 Telling not to interrupt/disturb	3
		<b>1.3 Requests and offers</b> 1.3.1 Making requests 1.3.2 Offers: Offering, Accepting, Declining 1.3.3 Excuses: Asking to be excused, Excusing 1.3.4 Permission: Asking for permission, Giving permission	3
		<b>1.4 Expressing</b> 1.4.1 Likes/dislikes	3

Units	Topics	Contents	Hours
		1.4.2 Hopes/wishes 1.4.3 Advice/suggestions/recommendations 1.4.4 Prohibitions	
<b>2</b>	<b>Comprehension and Writing skills</b>		<b>16 hrs</b>
		2.1 Comprehension passages	3
		2.2 Technical Terms	3
		2.3 Writing Paragraphs	2
		2.4 Writing letters 2.4.1 Resume/bio-data 2.4.2 Applications letters 2.4.3 Business letters	4
		2.5 Writing work reports	4
<b>३</b>	<b>नेपाली संचार</b>		<b>१२ घण्टा</b>
		३.१ प्राविधिक शब्दहरु	२ घण्टा
		३.२ बोध अभिव्यक्ति	२ घण्टा
		३.३ अनुच्छेद लेखन	२ घण्टा
		३.४ पत्रलेखन: क. व्यापारिक पत्र ख. निवेदन पत्र ग. व्यक्तिगत विवरण (बायोडाटा) लेखन	३ घण्टा
		३.५ कार्य प्रतिवेदन लेखन	३ घण्टा
<b>4</b>	<b>Motivation, Attitudes, Decision Making &amp; Creativity</b>		<b>8 hrs</b>
		<b>4.1 Motivation:</b> 4.1.1 Self-motivation 4.1.2 Features of self-motivation • Honesty, • Enthusiasm, • Dedication • Productiveness	2
		<b>4.2 Attitudes:</b> 4.2.1 Positive and Negative attitudes 4.2.2 Factors affecting attitudes 4.2.3 Positive attitude and advantages 4.2.4 Negative attitude & disadvantages	2
		<b>4.3 Decision Making to solve problem:</b> 4.3.1 Decision making and problem solving; 4.3.2 Steps of problem solving; 4.3.3 Steps of decision making process.	2
		<b>4.4 Creativity</b> 4.4.1 Meaning 4.4.2 Purpose 4.4.3 Technique to improve creative thinking skills.	2
<b>5</b>	<b>Stress and Time Management</b>		<b>6 hrs</b>
		<b>5.1 Stress Management</b> 5.1.1 Definition of stress	3

Units	Topics	Contents	Hours
		5.1.2 Causes and consequences of stress 5.1.3 Stress management techniques	
		<b>5.2 Time Management</b> 5.2.1 Meaning 5.2.2 Time wasters 5.2.3 Effective time management strategy	3
<b>6</b>	<b>Team work and Leadership</b>		<b>6 hrs</b>
		<b>6.1 Team Work</b> 6.1.1 Definition 6.1.2 Purpose 6.1.3 Characteristic of champion team 6.1.4 Interpersonal relationship	3
		<b>6.2 Leadership Skill</b> 6.2.1 Leadership Power 6.2.2 Leadership Styles 6.2.3 Public Speaking and Presentation	3

### Practical

30 hrs

Units	Task	Hours
1	1.1 Compose a dialogue introducing new friend in the class. 1.2 Compose a dialogue ting new friend in the class. 1.3 Make a request to the teacher for checking your practical work. 1.4 Compose a dialogue offering drinks to the (supposed) guests.	5
2	2.1 Prepare your own resume/bio-data. 2.2 Write a job application. 2.3 Write a letter to the Business Company or industry for the delivery of goods. 2.4 Write a report of a complete task you performed.	5
३	३.१. नेपाली निवेदन लेख्नुहोस् । ३.२. आफुनो अभ्यास कार्यलाई आवश्यक पर्ने सामान अर्डर गरी सम्बन्धित उद्योगलाई एक पत्र लेख्नुहोस् । ३.३. आफुनो व्यक्तिगत विवरण तयार पार्नुहोस् । ३.४. वर्तमान सन्दर्भमा सूचना प्रविधिको आवश्यकता विषयमा २५० शब्दमा एक निबन्ध लेख्नुहोस् । ३.५. आफूले एक दिन गरेको अभ्यासका आधारमा कार्य प्रतिवेदन लेख्नुहोस् ।	5
4	4.1 Demonstrate and show the self-motivate people's behaviors in class room. 4.2 Demonstrate and show the positive and negative attitudes peoples behave in class room. 4.3 Take decision using decision making process on given problems by class teacher. 4.4 Perform the creativity skill on class room on the given situation.	5
5	5.1 Perform the stress management techniques in class room. 5.2 Perform the time management techniques in class room.	5

<b>Units</b>	<b>Task</b>	<b>Hours</b>
6	6.1 Perform the team building practices and team work activities in class room. 6.2 Perform public speaking applying presentation skills on given topic in class room.	5

**References:**

1. GRANT TAYLOR, English conversation practice,
2. R C Poudel, A manual to communicative English, K P PustakBhandar Dilli bazaar,
3. Kathmandu.
4. लालानाथ सुवेदी, इन्जिनियरिङ्ग नेपाली
5. Surya Sinha (2017). Complete Personality Development Course (Hindi Edition).
6. Hurlock, E.B (2006). Personality Development, 28th Reprint. New Delhi: Tata McGraw Hill
7. Lucas, Stephen (2001). Art of Public Speaking. New Delhi. Tata - Mc-Graw Hill.

# Industrial Practice

## Description:

The training institute will make arrangement for apprenticeship. Admitted trainees will have the three parties training agreement among trainees, sponsoring industries and training institute. The Agreement terms and conditions will be implemented during the whole training period.

The proposed apprentice students have three and half months (15 weeks) theoretical and practical classes in the training institute. After completing the 15 weeks training in training institute, students will be placed in industries working in Automobile sectors as an apprentice under the supervision of In-company Trainer, where as industrial practice & related skills will be learned. The nature of the training is practical works and the duration will be of approximately 18 months (78 weeks/3120 hours). Students will work in the related sponsoring industries for 5 days a week and come to the training institute 1 day per week.

Students will work in all five areas for first 54 weeks as mentioned in the structure of this curriculum. Remaining 24 weeks industrial practice will be specialized in any one or all area as per the need of industry and interest of the trainees. Counselling classes will be organized by the training institution prior to take the decision of specialization. Assignments and skills to be performed during the industrial practice period are given below in this curriculum.

## General objectives:

The objective of the apprenticeship is to make students familiar with/gain firsthand experience of the world of work as well as to provide them an opportunity to acquire skills that are theoretically learnt in the institute.

## Complete Apprenticeship plan

S. N.	Activities	Duration	Remarks
1	Orientation	Two days	Before Apprenticeship
2	Report to the site	One day	Before placement
3	Actual work at site	78 weeks	During apprenticeship
4	Evaluation by the sponsoring industries		Regular
6	Evaluation by the training Institute		At least one time in every three months
7	Final evaluation		Last month of the apprenticeship programme by the Industries
6	Final report preparation and presentation	5 days	After completion of apprenticeship

## Note:

- Students should maintain the daily diary during the apprenticeship programme.
- Students should prepare the apprenticeship report and present in training institution in the presence of In-company Trainer.
- Evaluation of apprenticeship programme should be done by the In-company Trainer (Industrial Supervisor).

# Industrial Orientation

## Course Description:

The students will be assigned to various auto-workshop/service stations on a full-time basis as a trainee or intern. At the end of the course, students will submit a report conforming to a standard format along with the daily diary. Industrial orientation shall consist of exposure of work to learn skills and techniques in operation, diagnosis, maintenance and repair of automobile vehicle concerns based on the nature of the interned organization.

## Course Objectives:

After completing the course, the students will be able to:

- Match the technical skills learn in the institute with the needs of the employer.
- Increase self-confidence to face the real work of world.
- Develop the strong linkage between industry and institution.
- Ensure the standard of the training as per the market demand.
- Sensitize with modern and new technologies applied in the industry.

The company/industry/organizations may provide orientations focusing on following areas:

1. Profile of the Industry
2. Mission, Vision, Value and believes
3. Layout of Workshop/industry
4. Basic features of the workshop
5. The service provided by industry
6. Organization structure of the industry
7. Special technology adapted
8. Safety concerns of the workshop
9. General rule and regulations of the workshop
10. Departmental divisions and their responsibility and functions
11. General problems in the workshop
12. Make them familiar with their supervisors, departmental head and staffs.
13. Prepare a plan to utilize the interns in systematic way and daily record keeping.

**Format/Content of Report:**

A report needs to be submitted by student on the basis of the following minimum guidelines at the end of their industrial intern.

- A hardcopy of report with simple binding.
- The font through-out the report must be of 12 size and Times New Roman.
- Cover page including name of Institute, industry, student and report submission date.
- Approval page from the side of Industry.
- Acknowledge
- Abstract
- Table of contents
- Chapter one: Introduction
  - Background of apprenticeship program
  - Introduction to industry, goal and organizational structure with role
  - Product/ Service summary of the industry
- Chapter two: Description of the Industry
  - Industry/workshop layout
  - Department/unit with their responsibility
  - List of major tools and equipment with their functions
  - Material handling equipment with purpose.
- Chapter three: Practices on the industry
  - Basic and frequent practices
  - Special Practices
  - Special technology found on industry and vehicle
- Chapter four: Conclusion and recommendation
  - Conclusion on attachment: practices, industry management and human behavior, problems and better terms.
  - Recommendation for industry: practices, industry management and human behavior, any other personnel opinion
- References if any
- Annexes: Daily dairy, drawings, photographs and so others.

## Control and Suspension System

(10 Weeks – 400 hours)

### A. Repair Suspension System

S. N.	Assignments	Skills
1.	Identify and locate Suspension Components	<ul style="list-style-type: none"> <li>- Identify suspension components</li> <li>- Locate suspension components</li> </ul>
2.	Change Coil Spring	<ul style="list-style-type: none"> <li>- Determine the types of suspension system whether it is McPherson strut type or independent coil spring types.</li> <li>- Lift the vehicle side of the coil spring to be removed and place safety stands.</li> <li>- Apply hand brakes if equipped and works.</li> <li>- Chock the other wheels.</li> <li>- Remove shock absorbers from the coil spring side.</li> <li>- Clamp the coil spring by using coil spring compressor.</li> <li>- Raise the jack little by little until the coil spring is free from vehicle load.</li> <li>- Remove the coil spring along with spring compression tool.</li> <li>- Unfasten the coil spring compressor and remove coil spring.</li> <li>- Check the strength and compression force of the coil spring.</li> <li>- Get new or replacement coil spring.</li> <li>- Clamp the new coil spring.</li> <li>- Replace the clamped spring to its position.</li> <li>- Remove coil spring compressor.</li> <li>- Install the shock absorber.</li> <li>- Lower the jack and remove safety stand and chock.</li> <li>- Repeat the performance steps until all the coil spring changed from the vehicle.</li> </ul>
3.	Change Shock Absorber / Strut	<ul style="list-style-type: none"> <li>- Determine the types of suspension system whether it is McPherson strut type or independent coil spring types.</li> <li>- Lift the vehicle side of the strut to be removed and place safety stands.</li> <li>- Apply hand brakes or chock the wheels.</li> <li>- Remove shock absorbers from the coil spring side.</li> <li>- Clamp the coil spring by using coil spring compressor.</li> <li>- Raise the jack little by little until the coil spring</li> </ul>

		<p>is free from vehicle load.</p> <ul style="list-style-type: none"> <li>- Remove the coil spring along with spring compression tool.</li> <li>- Remove the strut and control arms.</li> <li>- Unfasten the coil spring compressor and remove coil spring.</li> <li>- Check the strength and compression force of the coil spring.</li> <li>- Check the condition of the strut.</li> <li>- Get new or replacement strut.</li> <li>- Install the strut to it's position.</li> <li>- Clamp the new or replacement coil spring.</li> <li>- Replace the clamped spring to its position.</li> <li>- Remove coil spring compressor.</li> <li>- Install the shock absorber.</li> <li>- Lower the jack and remove safety stand and chock.</li> <li>- Repeat the Performance steps until all the coil spring changed from the vehicle.</li> </ul>
4.	Change Stabilizer bar and Bush	<ul style="list-style-type: none"> <li>- Jack up vehicle and support on stands.</li> <li>- Apply hand brakes or chock the wheels</li> <li>- Remove wheel.</li> <li>- Loosen the stabilizer link bolts.</li> <li>- Remove stabilizer link.</li> <li>- Remove stabilizer bar.</li> <li>- Check the stabilizer.</li> <li>- Obtain new or replacement stabilizer.</li> <li>- Replace stabilizer.</li> <li>- Replace new suspension bushes.</li> <li>- Install stabilizer link.</li> <li>- Torque the stabilizer link bolts.</li> <li>- Lower the jack and remove safety stand and chock.</li> </ul>
5.	Adjust Toe in toe out	<ul style="list-style-type: none"> <li>- Adjust Toe in toe out</li> </ul>
6.	Replace suspension Bush	<ul style="list-style-type: none"> <li>- Place vehicle on lift and raise.</li> <li>- Remove and replace rubber or metal eye bush from leaf spring if fitted.</li> <li>- Remove and replace lower and upper eye bush from shock absorber.</li> <li>- Remove and replace rubber bush from stabilizer bar.</li> <li>- Remove and replace rubber damper from coil spring.</li> <li>- Repeat all performance steps until the replacement of bushes on the suspension system complete.</li> <li>- Check for bush or pin wear and replace if</li> </ul>

		<p>necessary.</p> <ul style="list-style-type: none"> <li>- Install all parts that were removed to gain access the suspension bush replacement.</li> </ul>
7.	Change Suspension/ Control Arm	<ul style="list-style-type: none"> <li>- Locate the suspension arm needs replacement.</li> <li>- Place vehicle on lift and rise.</li> <li>- Remove wheels and tires.</li> <li>- Support the vehicle to make the suspension arm free from load.</li> <li>- Remove bracket or other hardware to gain access to the suspension arm.</li> <li>- Remove the lower/upper or both control arm from axle or frame/chassis.</li> <li>- Repeat these Performance steps to both left and right sides of front and rear of the vehicle to remove the suspension arms.</li> <li>- Check the stiffness and straightness of the arms.</li> <li>- Replace new arms or bushes to the frame.</li> <li>- Check for bush or mounting bolts wear or slip, replace if necessary.</li> <li>- Install all parts that were removed to gain access the suspension arm replacement.</li> </ul>
8.	Replace spring hanger/shackle pin.	<ul style="list-style-type: none"> <li>- Determine the types of spring hanger requiring replacement.</li> <li>- Apply hand brakes.</li> <li>- Lift the vehicle under the differential and place safety stands.</li> <li>- Place the chocks under one of the wheels not being raised.</li> <li>- Support the body of the vehicle near to the spring hanger.</li> <li>- Remove shackle pin lock nut and shackle pin.</li> <li>- Remove spring hanger mounting nuts from body/frame of the vehicle.</li> <li>- Raise the jack little by little until the spring hanger is free from vehicle load.</li> <li>- Remove the spring hanger.</li> <li>- Check the metal or rubber eye bush, shackle pin and hanger.</li> <li>- Get new or replacement shackle pin, bush and spring hanger.</li> <li>- Replace the spring hanger with new bush in its position.</li> <li>- Align the eye hole of main leaf coincide with shackle pin and hanger.</li> <li>- Install the shackle pin and lock it.</li> <li>- Lower the jack and remove safety stands and chock.</li> </ul>

		<ul style="list-style-type: none"> <li>- Repeat the performance steps to next leaf spring.</li> </ul>
9.	Replace Leaf Spring	<ul style="list-style-type: none"> <li>- Determine and locate the leaf spring requiring replacement.</li> <li>- Apply hand brakes.</li> <li>- Lift the vehicle under the differential and place safety stands.</li> <li>- Place the chocks under one of the wheels not being raised.</li> <li>- Raise the jack little by little until the spring hanger is free from vehicle load.</li> <li>- Support the body of the vehicle near to the leaf spring hanger.</li> <li>- Remove the shackle pin.</li> <li>- Remove U-bolts and clamp plate from axle housing.</li> <li>- Lift the leaf spring assembly from vehicle.</li> <li>- Clamp the spring leaves assembly to bench vice.</li> <li>- Remove the leaf spring metal clamps.</li> <li>- Remove center bolt from leaf spring assembly.</li> <li>- Separate spring leaves.</li> <li>- Examine the soft and broken leaves.</li> <li>- Get new spring leaves as per sizes.</li> <li>- Clamp the set of spring leaves with center bolt and metal clamps.</li> <li>- Check the metal or rubber eye bush, shackle pin and hanger.</li> <li>- Get new or replacement shackle pin, bush and spring hanger.</li> <li>- Replace the spring hanger with new bush in its position.</li> <li>- Install the leaf springs to its position.</li> <li>- Align the eye hole of main leaf coincide with shackle pin and hanger.</li> <li>- Install the shackle pin and lock it.</li> <li>- Mount the U-bolts to the axle housings.</li> <li>- Lower the jack and remove safety stands and chock.</li> <li>- Repeat the performance steps to next leaf spring.</li> </ul>
10.	Replace Torsion bar	<ul style="list-style-type: none"> <li>- Lift the vehicle and place safety stands.</li> <li>- Apply hand brakes or chock the wheels.</li> <li>- Remove RR wheels and Tyres</li> <li>- Remove parking brake Cable clip and loosen the bracket bolts. In case RR disc brake, remove RR brake caliper assembly and suspend it with wires.</li> <li>- Remove the brake upper return spring, adjuster assembly, and Shoe Holder. In case of Disc brake, Remove RR Hub and carrier assy by</li> </ul>

		<p>loosen the mounting bolts.</p> <ul style="list-style-type: none"><li>- Remove parking brake cable from brake Shoe.</li><li>- Remove the wheel cylinder, brake hose bracket bolt, and remove hub assembly by loosen the mounting bolts</li><li>- Support lower portion of torsion axle with safety jack.</li><li>- Remove rear Shock absorber.</li><li>- Remove torsion axle from Body loosening the mounting bolt.</li><li>- Inspect and Replace new torsion bars.</li><li>- Replace all parts that were removed earlier in reverse order.</li><li>- Lower the vehicle from jack/ Lift and remove safety stand and chock.</li></ul>
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## B. Repair Steering System

S. N.	Assignments	Skills
1.	Identify and locate Hydraulic power steering, EHPS and EPS Components	<p>Identify and locate <b>Electronic Power Steering (EPS)</b></p> <ol style="list-style-type: none"> <li>1. Steering wheel</li> <li>2. EPS Controller</li> <li>3. EPS motor</li> <li>4. EPS Warning Lamp</li> <li>5. Rack and Pinion</li> <li>6. Torque sensor</li> </ol> <p><b>Hydraulic</b></p> <ol style="list-style-type: none"> <li>1. Steering wheel</li> <li>2. Steering Gear Box</li> <li>3. Oil Pump</li> <li>4. Oil Reservoir</li> <li>5. Suction Hose</li> <li>6. Pressure Hose</li> <li>7. Return Hose</li> <li>8. Direction control valve</li> </ol>
2.	Adjust Steering Wheel Free Play	<ul style="list-style-type: none"> <li>- Raise the front Wheels off the ground.</li> <li>- Check for free play within specifications.</li> <li>- If free play is excessive check to see that looseness is not caused by worn tie rod ends or worn idler arm bracket bushing or drop arm.</li> <li>- Access to adjusting screw.</li> <li>- Loosen the lock nut and turn the adjusting screw slightly, tighten the lock nut with specified torque.</li> <li>- Examine the steering wheel free play and adjust again if necessary.</li> </ul>
3.	Change Steering Wheel/ Bush	<ul style="list-style-type: none"> <li>- Disconnect battery terminals.</li> <li>- Remove the check nut to steering wheel.</li> <li>- Disconnect the wire or connector from steering wheel.</li> <li>- Remove steering wheel by using puller.</li> <li>- Check steering wheel bush for wear.</li> <li>- Replace new bush if worn.</li> <li>- Check the crack or deformation of spoke on steering wheel.</li> <li>- Replace new or replacement steering wheel.</li> <li>- Lock the steering wheel by tightening check nut or woodruff key.</li> <li>- Check the steering wheel free play: adjust if necessary.</li> </ul>

		<ul style="list-style-type: none"> <li>- Connect wires or connector to the steering wheel.</li> <li>- Cover the check nut of the steering wheel.</li> </ul>
4.	Change Steering Column	<ul style="list-style-type: none"> <li>- Loosen the bolts on both sides of the steering wheel.</li> <li>- Disconnect the connectors and ..... airbag modules (if equipped) from steering wheel.</li> <li>- Remove the lock nut &amp; remove steering wall.[use SST]</li> <li>- Loosen the screw and remove steering column upper and lower shroud and multifunction switch.</li> <li>- Remove the clock spring from steering column shaft.</li> <li>- Remove the crash pad lower panel.</li> <li>- Loosen the bolt and then disconnect the universal joint assembly from the pinion of the steering gear box. Lock the steering wheel on straight ahead position.</li> <li>- Remove the steering column by loosening the mounting bolt &amp; nuts.</li> <li>- Loosen the bolt &amp; disconnect the universal joint assembly from the steering column assembly.</li> <li>- Check steering column for damage, deterioration, wear &amp; oracles.</li> <li>- Check the key lock assembly for proper operation and replace if necessary.</li> <li>- Reassembly in the reverse order of disassembly.</li> <li>- Check for proper functioning of steering wheel, horn, airbag, tilt &amp; telescope function if equipped.</li> </ul>
5.	Change Intermediate Shaft	
6.	Change Steering Rack Bush	<ul style="list-style-type: none"> <li>- Disconnect tie rod ball joints.</li> <li>- Disconnect steering shaft coupling/flange.</li> <li>- Disconnect drop arm or steering arm from rack &amp; pinion steering gear box.</li> <li>- Remove steering gear box.</li> <li>- Unscrew the rack bush mounting clamp/clip.</li> <li>- Remove rack bushes from both sides.</li> <li>- Replace new or replacement rack bushes.</li> <li>- Clamp the rack bushes.</li> <li>- Check the steering gear free play: adjust if necessary.</li> <li>- Inspect the rack &amp; pinion operation by rotating the rack shaft.</li> <li>- Fill the steering oil/grease if necessary.</li> <li>- Install the steering gear box.</li> <li>- Connect the drop arm/steering arm and ball joints.</li> <li>- Check the operation of the steering.</li> </ul>

7.	Change / Service Steering gear (Assembly Hydraulic)	<ul style="list-style-type: none"> <li>- Drain the power steering fluid.</li> <li>- Disconnect the pressure hose, pressure switch and return hose.</li> <li>- Loosen the bolt &amp; disconnect the universal joint assembly from the pinion of the steering gear box.</li> <li>- Remove the spilt pin and castle nut and then disconnect the tie rod end from the front knuckle.[use sst]</li> <li>- Remove lower arm and stabilizer link.</li> <li>- Loosen the bolt &amp; remove steering gear box.</li> <li>- Remove tie rod end, dust cover, bellows band clip &amp; then bellows.</li> <li>- Remove feed tube from rack housing.</li> <li>- Remove the tie rod.</li> <li>- Remove yoke plug, rack support spring &amp; yoke.</li> <li>- Remove the rack bushing and rack from the rack housing by removing circlip.</li> <li>- Remove oil seal &amp;oring rack bushing</li> <li>- Remove valve from body from valve body housing with soft hammer.</li> <li>- Remove oil seal &amp; ball bearing from valve body (Use SST).</li> <li>- Remove oil seal &amp;oring from rack housing.</li> <li>- Using SST remove the oil seal from the rack housing.</li> <li>- Inspect the rack by checking rack troth face damage or wear, seal contact surface damage, rack bending in twisting, oil seal damage or wear.</li> <li>- Inspect pinion by checking pinion gear tooth face damage or wear, seal content surface damage, seal ring damage or wear, oil seal damage or wear.</li> <li>- Inspect bearing by chocking seizure or abnormal noise during bearing rotation.</li> <li>- Inspect for damage of rack housing, cylinder bore, boot damage etc.</li> <li>- Reasemble in the reverse order of disassembly.</li> <li>- Fill the plsteeringfuid, bleed and retest.</li> </ul>
8.	Change Tie Rod end and ball joints	<ul style="list-style-type: none"> <li>- Raise the car if necessary and place safety stands under frame.</li> <li>- Loosen the lower nut of tie rod end or ball joint.</li> <li>- Turn the steering wheel to access to work on tie rod end.</li> </ul>

		<ul style="list-style-type: none"> <li>- Remove tie rod end or ball joint by using puller or gently hammering the pitman/steering arm or tie rod.</li> <li>- Loosen the tie rod end from tie rod shaft.</li> <li>- Remove the ball joints or tie rod end.</li> <li>- Replace the new tie rod end or ball joints.</li> <li>- Tighten the ball joints nuts.</li> <li>- Check all work.</li> <li>- Lower vehicle and remove jack stands.</li> </ul>
9.	Service/Repair Steering gear box	<ul style="list-style-type: none"> <li>- Determine the types of steering gearbox and follow the service manual for servicing.</li> <li>- Remove steering wheel cap and nut.</li> <li>- Remove steering wheel by using puller.</li> <li>- Remove all parts/components to gain access to remove steering gear box.</li> <li>- Remove pitman arm/drop arm from cross shaft.</li> <li>- Remove worm shaft to steering shaft universal joint.</li> <li>- Remove steering gear housing to frame fasteners and pull gearbox housing.</li> <li>- Clean the exterior of the gearbox housing thoroughly and remove the cover.</li> <li>- Drain steering gear oil.</li> <li>- Disconnect the pitman/steer shaft adjusting screw from the pitman shaft.</li> <li>- Pull the pitman shaft/cross shaft from the housing.</li> <li>- Loosen the worm bearing adjuster lock and remove adjuster and worm gear shaft or steering shaft.</li> <li>- Clean all parts with solvent.</li> <li>- Inspect bearings, cups and worm shaft bearing surface.</li> <li>- Check pitman shaft and worm shaft for wear.</li> <li>- Get new or replaced parts as needed.</li> </ul>
10.	Replace Power Steering Belt	<ul style="list-style-type: none"> <li>- Remove all components to gain access for steering belt.</li> <li>- Turn the tensioner bolt clockwise, compressing the tensioner, and releasing the tension on the serpentine accessory drive belt</li> <li>- Remove the power steering belt</li> <li>- Install the new belt looping the serpentine accessory drive belt loosely over the pulleys.</li> <li>- Tighten the belt with tensioner.</li> <li>- Install all components in reverse order that was used to gain access for steering belt</li> </ul>
11.	Repair Electric power steering system	<ul style="list-style-type: none"> <li>- Use Scanner to retrieve DTC's abddata analysis.</li> </ul>

		<ul style="list-style-type: none"> <li>- Remove steering column</li> <li>- Check for child parts if any defet, malfunction, noise, wear etc.</li> <li>- Change the child parts of electrical power steering system as per necessity.</li> <li>- Check motor, replace it.</li> <li>- Check EPS control module. replace if defective.</li> <li>- Check spider, replace if defective.</li> </ul>
12.	Change Steering oil	<ul style="list-style-type: none"> <li>- Open the steering oil filler plug/cap.</li> <li>- Check the gear oil level.</li> <li>- Inspect the quality/properties of gear oil.</li> <li>- Add the specified grade of steering oil.</li> <li>- Maintain the oil level.</li> <li>- Remove the drain plug to drain the steering oil if the oil has low viscous.</li> <li>- Drain the steering oil.</li> <li>- Tighten the drain plug</li> <li>- Refill the specified grade of steering oil.</li> <li>- Check the level of oil.</li> <li>- Add oil if level is low.</li> </ul>
13.	Perform Wheel Alignment and Balancing	<ul style="list-style-type: none"> <li>- Park the vehicle in a leveled ground.</li> <li>- Lift a wheel by a jack.</li> <li>- Check the statically balance of the wheel.</li> <li>- Rotate the wheel.</li> <li>- Check the run out/balance.</li> <li>- perform wheel balancing on Wheel balancing machinestatically or dynamically.</li> <li>- Check the wear ness of the tyre grip.</li> <li>- Rotate the tyre as specified in the manual.</li> <li>- Adjust the Toe in Toe out using Wheel Alignment Machine.</li> </ul> <p>Wheel Alignment</p> <ul style="list-style-type: none"> <li>- Separate the clamps from the both rack and pinion boots.</li> <li>- Loosen the right and the left tie rod end lock nuts.</li> <li>- Turn the right and the left tie rod to align the toe. In this adjustment, the right and left tie rods mustbeequal in length.</li> <li>- Tighten the tie rod end lock nut to specified torque</li> <li>- Install the rack and pinion boots and clamp.</li> </ul> <ul style="list-style-type: none"> <li>- Tighten the wheel nut in cross method</li> </ul>

## C. Repair Brake System

S. N.	Assignments	Skills
1.	Identify and locate Brake System Components according to various types of Automobile	Identify and locate Brake System Components according to various types of Automobile
2.	<b>Change brake shoe.</b>	<ul style="list-style-type: none"> <li>- Apply hand brake or choke the wheel</li> <li>- Place the jack to the frame or support near to the wheel.</li> <li>- Loosen the wheel nut.</li> <li>- Lift the jack to make the wheel free from ground.</li> <li>- Remove the wheel nut and wheel.</li> <li>- Remove the brake drum.</li> <li>- Remove the brake shoe return/retracting spring.</li> <li>- Remove brake shoe hold down pin, spring and caps assembly.</li> <li>- Change the new brake shoes.</li> <li>- Clamp the shoe by using shoe hold down pin, spring and caps.</li> <li>- Insert the brake shoe return springs to their proper order.</li> <li>- Adjust the brake shoe adjuster cam or screw.</li> <li>- Refit the brake drum.</li> <li>- Tight the screws of brake drum.</li> <li>- Adjust brake if required.</li> <li>- Fit the wheel.</li> <li>- Remove the jack.</li> <li>- Tighten the wheel nuts in cross method.</li> </ul>
3.	<b>Change Master cylinder.</b>	<ul style="list-style-type: none"> <li>- Locate the manufacturer's information on the vehicle.</li> <li>- Open the front bonnet or engine hood.</li> <li>- Drain the brake fluid.</li> <li>- Remove all components to gain access to remove the master cylinder.</li> <li>- Remove master cylinder assembly.</li> <li>- Replace master cylinder.</li> <li>- Replace all components that were removed to gain access to MC.</li> <li>- Fill brake fluid to master cylinder reservoir.</li> <li>- Perform brake bleeding.</li> <li>- Check all work.</li> <li>- Road test vehicle to check performance.</li> </ul>
4.	<b>Change wheel cylinder.</b>	<ul style="list-style-type: none"> <li>- Locate the manufacturer's manual on the vehicle requiring the removal and replacement of WC.</li> <li>- Jack up wheels and place jack stands.</li> <li>- Remove wheels.</li> </ul>

		<ul style="list-style-type: none"> <li>- Drain the brake fluid.</li> <li>- Remove brake drum.</li> <li>- Remove brake return springs, shoes and other parts to gain access to remove the wheel cylinder from brake back plate.</li> <li>- Remove wheel cylinder.</li> <li>- Replace wheel cylinder.</li> <li>- Replace all components that were removed to gain access to WC.</li> <li>- Adjust brakes if necessary.</li> <li>- Fill brake fluid to master cylinder.</li> <li>- Perform brake bleeding.</li> <li>- Replace wheels and tyres.</li> <li>- Check all work.</li> <li>- Lower vehicle.</li> <li>- Road test vehicle to check performance.</li> </ul>
5.	<b>Replace brake pad and disc.</b>	<ul style="list-style-type: none"> <li>- Jack up vehicle and support on stands.</li> <li>- Remove wheels.</li> <li>- Remove split pins and spring retaining clips.</li> <li>- Remove worn pad.</li> <li>- Check disc for scoring and /or damage.</li> <li>- Push operating pistons as far as possible into cylinder bores.</li> <li>- Insert new pads and ensure that they are correctly positioned.</li> <li>- Fit new spring retaining clips and split pins.</li> <li>- Operate brake pedal until correct operation is achieved.</li> <li>- Check fluid level, replenish if necessary.</li> </ul>
6.	<b>Change brake booster.</b>	<ul style="list-style-type: none"> <li>- Locate the manufacturer's information on the vehicle requiring the removal and replacement of brake booster.</li> <li>- Lift the bonnet.</li> <li>- Remove all components to gain access to brake booster.</li> <li>- Disconnect brake hosepipe.</li> <li>- Loosen securing bolts or nuts to master cylinder and brake booster.</li> <li>- Remove master cylinder.</li> <li>- Remove brake booster assembly.</li> <li>- Install new brake booster and master cylinder.</li> <li>- Replace all components that were removed to gain access to booster.</li> <li>- Check and complete all work.</li> </ul>
7.	Adjust Brake	<p><b>Brake shoe adjustment:</b></p> <ul style="list-style-type: none"> <li>- Jack up vehicle until wheel to be adjusted is just clear of ground.</li> </ul>

		<ul style="list-style-type: none"> <li>- Clear dirt from adjusters and surrounding.</li> <li>- Turn each adjuster in clockwise direction until the brake shoes lock the brake drum.</li> <li>- Slacken off adjuster until wheel spins freely.</li> <li>- Repeat on remaining wheels.</li> <li>- NOTE: Ensure that the hand brake has been released before adjusting the rear wheel brakes.</li> </ul> <p><b>Hand brake adjustment:</b></p> <ul style="list-style-type: none"> <li>- Jack up vehicle until rear wheels are clear of the ground.</li> <li>- Support on the axle stands.</li> <li>- Release hand brake.</li> <li>- Check manufacturer's instructions before adjusting hand brake.</li> <li>- NOTE: On some vehicle the hand brake cable can be adjusted at the rear of the hand brake lever. Always consult manufacturer's manual before commencing any adjustment.</li> <li>- Adjust hand brake cable adjuster until the shoes contact with the drum.</li> <li>- Slacken adjuster sufficiently to allow the wheel to rotate freely.</li> <li>- Check hand brake linkage for wear.</li> <li>- Adjust and lubricate as necessary.</li> </ul>
8.	Bleed Hydraulic Brake	<ul style="list-style-type: none"> <li>- Examine the master cylinder reservoir cap and ensure that the vent hole is clear.</li> <li>- Maintain the fluid level in the reservoir; it should be the specified level below the top of the reservoir face.</li> <li>- Check all unions and connections for tightness and freedom from leaks and check all the conditions of the flexible hoses.</li> <li>- Clean the area around the bleeding nipples.</li> <li>- Start bleeding at the nipple farthest from master cylinder and work to the nipple nearest this wheel cylinder.</li> <li>- Select any one of the wheel cylinder, which is the longest distance from master cylinder.</li> <li>- Insert one end of the clean rubber tube (about 300 mm) over bleeding nipple on the brake back plate</li> <li>- Position the free end of the tube in a glass jar partially filled with clean brake fluid; ensure the tube end is submerged in the fluid.</li> <li>- Press the brake pedal and unscrew bleed nipple half a turn.</li> <li>- In case of ABS equipped brake, use scanner</li> </ul>

		<p>or follow the service manual.</p> <ul style="list-style-type: none"> <li>- Check whether air bubbles are escaped through the tube, assistant should then press brake pedal firmly to floor.</li> <li>- Close the nipple and release pedal quickly.</li> <li>- Repeat performance steps 9 to 11 until all air is expelled from the system.</li> <li>- Close the bleed nipple when only brake fluid is pumped out with the pedal fully operated depressed.</li> <li>- Check fluid reservoir level frequently during this operation.</li> <li>- Remove the tube and repeat the operation on the other three wheels.</li> <li>- Check the fluid level on master cylinder during the bleeding operations on the other three wheels.</li> <li>- Fill the fluid level; use only the brake fluid recommended for the vehicle being worked on.</li> <li>- Adjust brake to correct setting and check position when all wheels have bleed.</li> </ul>
9.	<b>Remove and install parking brake lever.</b>	<p><b>Removal</b></p> <ul style="list-style-type: none"> <li>- Hoist vehicle and release parking brake lever.</li> <li>- Disconnect negative cable at battery</li> <li>- Disconnect lead wire of parking brake switch and coupler</li> <li>- Loosen parking brake cable stopper nut and remove adjusting nut</li> <li>- loosen parking brake cable bracket nut and remove parking brake cable from bracket</li> <li>- Remove parking brake lever bolts and then remove parking brake lever assembly.</li> </ul> <p><b>Installation:</b></p> <ul style="list-style-type: none"> <li>- Install reverse order of removal procedure.</li> <li>- After all parts are installed, parking brake lever needs to be adjusted.</li> <li>- Check brake drum for dragging and brake system for proper performance</li> </ul>
10.	<b>Inspect and adjust parking brake.</b>	<p><b>Inspection</b></p> <ul style="list-style-type: none"> <li>- Hold center of parking brake lever grip and pull it to specified force</li> <li>- With parking brake lever pulled up as above, count ratchet notch</li> <li>- It should be 5 to 8 notches.</li> <li>- Check both left and right wheels are locked firmly</li> <li>- If number of notches is out of specification, adjust cable.</li> </ul>

		<p><b>Adjustment:</b></p> <ul style="list-style-type: none"> <li>- Ensure the following condition of cable</li> <li>- No air is trapped in brake system</li> <li>- Brake pedal travel is proper</li> <li>- brake pedal has been depressed a few times without specified force</li> <li>- Parking brake lever has been pulled up a few times with specified force</li> <li>- Rear shoes are not worn beyond limit and self-adjustment mechanism operates properly</li> <li>- Conform all above, adjust parking brake lever stroke by loosening or tightening adjusting nut</li> </ul>
11.	<b>Remove and install parking brake cable.</b>	<ul style="list-style-type: none"> <li>- Raise suitably support vehicle and remove wheel if necessary</li> <li>- Disconnect brake cable from lever.</li> <li>- Remove parking brake cable(s)</li> <li>- Install new cable reversing removal procedure.</li> <li>- Install clamps properly.</li> <li>- Tighten bolts and nuts to specified torque</li> <li>- Upon completion of installation, adjust cable</li> </ul>
12.	<b>Replace vacuum pump.</b>	<p><b>Removal</b></p> <ul style="list-style-type: none"> <li>- Determine the location of vacuum pump.</li> <li>- Follow service manual.</li> <li>- Disconnect vacuum hose</li> <li>- Disconnect oil outlet hose if attached in alternator.</li> <li>- Remove pump mounting bolts</li> <li>- Remove the pump</li> <li>- Remove oil seal</li> </ul> <p>Disassembly of vacuum pump</p> <ul style="list-style-type: none"> <li>- Remove vacuum hose union and check valve</li> <li>- Remove oil outlet hose union</li> <li>- Tap pin down and remove end plate</li> <li>- Remove O- Ring</li> <li>- Remove rotor and blades</li> </ul> <p>Inspection</p> <ul style="list-style-type: none"> <li>- Inspect blade for wear or damage</li> <li>- Inspect check valve operation. Check that air flows from the hose side to the pump side. Also check air does not flow from pump side to the hose side</li> <li>- Inspect bushing and oil seal for wear or oil leakage at end frame of alternator</li> </ul> <p>Assembly</p> <ul style="list-style-type: none"> <li>- Install rotor into casing</li> <li>- Install blades with round end facing outward</li> </ul>

		<ul style="list-style-type: none"> <li>- Install a new O-Ring and end plate</li> <li>- Install check valve</li> </ul> <p><b>Installation:</b></p> <ul style="list-style-type: none"> <li>- Install new oil seal.</li> <li>- Install pump</li> <li>- Connect oil outlet hose</li> <li>- Install union to check valve</li> <li>- connect vacuum hose</li> <li>- check pump for operation</li> </ul>
13.	<b>Identify/locate components of ABS</b>	<p>Open the bonnet identify the following components:</p> <ul style="list-style-type: none"> <li>- Brake Master Cylinder</li> <li>- Master Cylinder Reservoir</li> <li>- Brake Fluid Level Switch Connector</li> <li>- Hydraulic electronic control unit</li> <li>- Instrument Cluster</li> </ul> <p>Lift the vehicle with hydraulic jack, use fixed stand and identify the components</p> <ul style="list-style-type: none"> <li>- Four Wheel Speed Sensors and Connector</li> <li>- ABS Wiring Harness</li> </ul>
14.	Diagnosis and Troubleshooting of ABS System	<ul style="list-style-type: none"> <li>- Diagnosis of ABS system using Scanner and Multimeter</li> <li>- Inspect wheel speed sensor</li> <li>- Inspect Hydraulic electronic control unit</li> <li>- Inspect Brake Switch</li> </ul>

**Power Trains**  
**(Transmission System)**  
**(10 Weeks – 400 hours)**

**A. Repair Clutch**

S. N.		Skill
1.	Removal of Clutch Plate From Vehicle	<ol style="list-style-type: none"> <li>1. Unlock and remove propeller shaft mounting screws. Disconnect it from gear box and suspend it sideways suitably.</li> <li>2. Disconnect speedo cable from gear box.</li> <li>3. Remove clutch release fork ball joint lock ring and disconnect clutch rod assembly.</li> <li>4. Remove gear box mounting bolts at the rear.</li> <li>5. Jack up the gear box a little and put wooden support to support engine.</li> <li>6. Remove gear box cover.</li> <li>7. Remove gear shift lever.</li> <li>8. Unscrew and remove four gear box mounting bolts.</li> <li>9. Pull the gear box towards rear and carefully lower it down.</li> <li>10. Unscrew clutch housing bottom cover mounting screws and remove cover.</li> <li>11. Mark clutch pressure plate with respect to fly wheel so that it can be refitted in the same position.</li> <li>12. Slide off rubber bellow from the release fork support outer bracket.</li> <li>13. Unscrew four bolts holding support bracket assembly to clutch housing and remove outer bracket.</li> <li>14. Pull out release fork with bearing from inner bracket. Remove retaining ring from bearing race and remove two halves of spherical bearing .take outer bracket from the release fork.</li> <li>15. Remove release fork with release bearing from inside of the housing.</li> <li>16. Remove release bearing assembly from fork by removing two hook springs.</li> <li>17. As an added safety measures, support clutch pressure plate and clutch disc with mandrel. Unscrew six mounting bolts evenly and equally in small steps.</li> <li>18. Remove clutch pressure plate assembly and clutch disc after taking out the mandrel.</li> </ol>
2	Inspection of Clutch Disc	<ol style="list-style-type: none"> <li>1. Check clutch disc hub splines for damage and wear. The clutch disc should slide easily on gear box drive shaft but not have excessive play and wobble.</li> <li>2. Check torsion damper mechanism springs for distortion damage etc. for this purpose, hold drive shaft in a vice, insert clutch disc and slide it as far as possible. Rotate disc by hand, rattling noise and excessive play indicates damage tensional damping mechanism and such disc must be replaced.</li> </ol>

		<ol style="list-style-type: none"> <li>3. Check disc facings for wear cracks, contact pattern, burning marks and oil contamination. Facing with any of the above defects or worn out beyond permissible limits must be replaced.</li> </ol>
3.	Inspection of Clutch Pressure Plate (coil spring type)	<ol style="list-style-type: none"> <li>1. Check pressure plate for cracks, scoring marks, over heating marks. If scored, the friction surface can be fine machined or ground up to specified mm. check the evenness of frictional surface with straight edge.</li> <li>2. Check fit of release lever pivot pins in holes in pressure plate. If the holes are worn out replace the pressure plate.</li> <li>3. Check visually for cracks, loose parts, etc.</li> <li>4. <u>Clutch housing cover</u></li> <li>5. Inspect for damage cracks, and distortions, if any.</li> <li>6. <u>Release Levers</u></li> <li>7. Check bores of needle bearing on levers for distortions if any.</li> <li>8. Check thrust surface of levers for wear cracks etc. Replace if necessary.</li> <li>9. Check release lever support holes and threads for damage, replace if necessary.</li> <li>10. <u>Springs</u></li> <li>11. Check clutch pressure springs for damage, sag and cracks. Replace if necessary.</li> <li>12. Always replace springs in complete set of one color.</li> <li>13. Check anti rattle springs in cover and replace if necessary.</li> <li>14. Check spring plates for cracks/wear .Replace if necessary.</li> <li>15. <u>Fly wheel</u></li> <li>16. Check for cracks, overheating and scoring marks, if required resting surface can be machined up to specified mm. Reduce spigot length also by the same amount.</li> <li>17. Check ball seat and bearing halves of clutch release fork, the seat of clutch pedal return spring for wear and replace if necessary.</li> <li>18. Check clutch release bearing for wear, over heating marks and free movement .Replace if necessary.</li> </ol>
4.	Release lever depth adjustment procedure	<ol style="list-style-type: none"> <li>1. Hold bottom plate of fixture in a vice mount pressure plate on it.</li> <li>2. Press down clutch cover by tightening the top plate of fixture.</li> <li>3. Check and adjust depth of release lever tips from bottom face to cover,</li> <li>4. Place height gauge over top plate of fixture and measure .release lever tip depth from the top plate. Let this reading be B. measure the depth of bottom surface of plate from top surface of fixture .let this reading be A. Adjust height B by tightening or loosening the nut on release lever support, in such way that difference of A-B = specified mm. the difference in tip height should not be more than 0.2mm.</li> <li>5. Assemble lock washer on nut and screw in locking screw.</li> <li>6. Unscrew nut of assembly fixture remove thrust bearing, and pressure plate assembly.</li> </ol>
5.	Installation of clutch plate on	<ol style="list-style-type: none"> <li>1. Clean friction face of flywheel and check for cracks, scoring, burn marks or unevenness if necessary machine fly wheel friction faces</li> </ol>

	vehicle	<p>just to clear the defect.</p> <ol style="list-style-type: none"> <li>2. Check spigot bearing in flywheel for free rotation. Replace sticky/damaged bearing. Fit new bearing after filling with new bearing grease and press in retaining cover. Lightly apply molykote grease on the disc splines. Install disc and pressure plate assembly (shorter length of spline hub on the clutch disc must face towards the flywheel).press aligning arbor through the clutch assembly and clutch disc and centralize clutch disc on fly wheel by locating the front end of the arbor in flywheel spigot bearing.</li> <li>3. Locate pressure plate housing on flywheel dowels in original position with the aid of marks and align mounting holes with tapped holes in flywheel.</li> <li>4. Screw in clutch mounting bolts with spring washer. Aligning arbor still in position, tighten mounting bolts evenly and equally (Alternately and cross wise) in small steps. Tighten these bolts in same sequence to specified torque.</li> </ol> <p>Note: Do not mix clutch mounting bolts with other fasteners. Do not use longer or shorter screw. Longer screws may not tighten the clutch at all .shorter screws will not provide enough threads to achieve desired tightening.</p> <ol style="list-style-type: none"> <li>5. While tightening clutch mounting bolts check aligning arbor for continuous free sliding to ensure concentric installation of clutch disc which will avoid trouble when installing gear box.</li> <li>6. Remove aligning arbor.</li> <li>7. Assemble clutch release bearing on fork. Fit retaining spring hooks. Make sure that spring hooks are properly seated and holding the assembly with sufficient grip.</li> <li>8. Smear inside of the sleeve with molykote grease slightly.</li> <li>9. Insert clutch fork with release bearing from inside of the housing and through the opening for support bracket. Insert inner bracket through the fork and locate it in the clutch housing.</li> <li>10. Smear ball seat of fork and inside of the bearing race with molykote grease.</li> <li>11. Remove retaining ring from bearing and assemble two half of the race on spherical seat of the fork. Refit retaining ring.</li> <li>12. Locate bearing race in inner bracket and at outer bracket.</li> <li>13. Screw in inner and outer bracket mounting bolts with spring washers and tighten them to specified toque.</li> <li>14. Fit rubber bellow on clutch fork and outer bracket.</li> <li>15. For installing the gear box proceed in reverse order of removal.</li> <li>16. Tighten gear box mounting front rear bolts to specified torque.</li> <li>17. Tighten coupling flange bolts to specified torque and lock the bolts head with lock plates.</li> <li>18. Fit clutch housing bottom cover and tighten mounting screws firmly.</li> </ol>
6.	Clutch Actuation Mechanism	<ol style="list-style-type: none"> <li>1. Connect bleeding tube to bleeding screw on slave cylinder</li> <li>2. Loosen bleeding screw on slave cylinder by 1 t to <math>\frac{3}{4}</math> of turn.</li> </ol>

	Removal	<p>Operate clutch number of times and pump out fluid in to a container.</p> <ol style="list-style-type: none"> <li>3. Remove bleeding tube.</li> <li>4. Disconnection pipe connection from master cylinder.</li> <li>5. Disconnect pipe connection from slave cylinder.</li> <li>6. Remove split pin and clevis pin locking master cylinder push rod fork end with clutch pedal.</li> <li>7. Unscrew and remove master cylinder mounting screws. Pull out master cylinder with push rod and filling container.</li> <li>8. Remove filling container cap and unscrew container mounting banjo bolt. Remove gasket.</li> <li>9. Remove locking wire for clutch release fork ball joint. Disconnect ball joint and remove slave cylinder push rod.</li> <li>10. Unscrew and remove slave cylinder mounting screws and pull out slave cylinder.</li> </ol>
7.	Dismantling of Master Cylinder	<ol style="list-style-type: none"> <li>1. Pull back dust cover.</li> <li>2. Remove circlip retaining push rod.</li> <li>3. Remove push rod with retaining washer.</li> <li>4. Remove plunger and valve assembly from body by lightly tapping the body on wooden block.</li> <li>5. Using screw driver, lift leaf of spring retainer .Remove spring assembly from plunger.</li> <li>6. Compress spring to free valve stem from eccentrically position hole in the end face of spring retainer .This will separate spring retainer from valve stem.</li> <li>7. Remove spring, valve spacer and spring washer from valve stem.</li> <li>8. Carefully remove valve seal from valve stem.</li> <li>9. Carefully remove gland seal from plunger.</li> </ol>
8.	Inspection and assembly of master cylinder	<ol style="list-style-type: none"> <li>1. Examine bore of body .If it is not scored, ridged, or corroded do not replace. If there is doubt about the condition of bore, new body should be used.</li> <li>2. Examine plunger for rust, burr and ridges. Replace if necessary.</li> <li>3. Fit new gland seal on plunger such that it fits squarely on plunger groove.</li> <li>4. Fit new valve seal on valve stem with smallest diameter leading.</li> <li>5. Assemble spring washer on valve stem such that it bends away from valve shoulder.</li> <li>6. Now assemble valve spacer on valve stem. Hold the spacer between fingers such that valve stem hangs down vertically. Pull the stem downwards as far as possible. Release the stem. Observe whether the valve stem has moved freely upwards.. If movement is not free replace valve spacer.</li> <li>7. Install spring over valve stem behind valve spacer followed by spring retainer. Compress spring And locate valve stem end in key hole slot of spring retainer.</li> <li>8. Fit spring assembly on plunger assembly and lock the leaf of spring retainer by pressing it with nose plier.</li> <li>9. Lubricate bore of body with brake fluid and dip plunger assembly</li> </ol>

		<p>in it .insert the assembly in to bore with valve end leading.</p> <p>10. Check condition of dust cover .If necessary replace.</p> <p>11. If disturbed adjust push rod length with fork.</p> <p>12. Place push rod with retaining washer on the plunger and fit circlip for retaining push rod in the body groove.</p> <p>13. Fit dust cover on body.</p>
9.	Dismantling of Slave cylinder	<ol style="list-style-type: none"> <li>1. Remove dust cover.</li> <li>2. Remove circlip.</li> <li>3. Remove plunger with gland seal and plunger spring from body by lightly tapping it on wooden block.</li> <li>4. Remove gland seal from plunger.</li> </ol>
10.	Inspection and assembly of slave cylinder	<ol style="list-style-type: none"> <li>1. Examine bore of body. If it is not scored ridged or corroded do not replace .if there is doubt about condition of bore new body should be used.</li> <li>2. Examine plunger for rust, burrs and ridges. Replace if necessary.</li> <li>3. Fit new gland seal on plunger such that it fits squarely in plunger groove and that flat face of plunger seal is towards push rod end of plunger.</li> <li>4. Fit small end diameter of spring to plunger</li> <li>5. Lubricate bore of body with brake fluid and dip plunger assembly in it. Insert plunger assembly in to bore with bigger end diameter of spring leading.</li> <li>6. Fit circlip.</li> <li>7. Check condition of dust cover .If necessary replace.</li> <li>8. Insert dust cover on body.</li> </ol> <p>Note: clutch master cylinder, clutch slave cylinder and their parts to be cleaned only in brake fluid.</p>
11.	Installation of clutch slave cylinder	<ol style="list-style-type: none"> <li>1. Mount slave cylinder on slave cylinder mounting bracket. Ensure that bleeding screw of slave cylinder is at top. Tighten slave cylinder mounting screws and nuts.</li> <li>2. Insert slave cylinder push rod in to slave cylinder and press ball socket on clutch release fork ball end. Lock ball joint with wire.</li> <li>3. Install filling container with gasket on master cylinder.</li> <li>4. Insert filling container mounting banjo bolt and tighten it fully.</li> <li>5. Install master cylinder on fire wall and tighten its mounting screws.</li> <li>6. Install anti-rattle washer between master cylinder push rod fork and clutch pedal .insert clevis pin. Install plain washer and lock clevis pin with split pin.</li> <li>7. Connect flexible pipe to slave cylinder.</li> <li>8. Connect flexible pipe to master cylinder.</li> </ol>
12	Bleeding The Clutch System	<ol style="list-style-type: none"> <li>1. Top up clutch fluid container.</li> <li>2. Ensure that fluid level in clutch fluid container is up to MAX level not above it. Add clutch fluid to maintain level while bleeding.</li> <li>3. Remove the dust cap from the slave cylinder bleed screw and clean the screw thoroughly. Attach bleeding tube to bleed screw and place other end of tube in a clean glass jar containing</li> </ol>

		<p>sufficient clutch fluid to submerge tube end.</p> <ol style="list-style-type: none"> <li>4. Pump clutch pedal twice or thrice slowly throughout its stroke and holding clutch pedal in depressed condition, loosen bleed screw on slave cylinder.</li> <li>5. Retighten bleed screw on slave cylinder and repeat the above operation until air bubble cease to appear at the end of tube in jar, allowing only fluid to flow.</li> <li>6. After completing bleeding operation, ensure that bleed screw on slave cylinder is fully tightened. Replace the dust cap on bleed screw.</li> </ol>
13.	Clutch Pedal Adjustment	Measure the clutch pedal height .If the clutch pedal height is not within specified value, adjust pedal height by turning push rod after loosening the lock nut.

## B. Repair Gear Box

S. N.	Assignments	Skills
1.	Remove Gear Box From the Vehicle:	<ol style="list-style-type: none"> <li>1. Disconnect battery positive terminal</li> <li>2. Put the wheel chocks.</li> <li>3. Open floor panel and remove gear shift lever assembly.</li> <li>4. Drain off gear box oil and refit the plug after cleaning.</li> <li>5. Unlock, remove screws and disconnect propeller shaft from the gear box.</li> <li>6. Disconnect clutch linkage.</li> <li>7. Disconnect Speedo meter cable from the gear box.</li> <li>8. Disconnect reverse light connection.</li> <li>9. Loosen rear mounting screws of bracket and hold gear box suitably.</li> <li>10. Lift the gear box slightly, insert wooden wedge in between engine support bracket</li> <li>11. Disconnect cross member.</li> <li>12. Unscrew and remove four gear box mounting screws while holding it suitably.</li> <li>13. Lower the gear box slowly and pull it out.</li> </ol>
2	Disassembling of gear box	<ol style="list-style-type: none"> <li>1. Mount gear box on work stand.</li> <li>2. Remove top cover mounting bolts Tap at the ends of top cover slightly and remove it carefully.</li> <li>3. Fit coupling flange holder on coupling flange</li> <li>4. Unstack coupling flange nut, and remove it using socket.</li> <li>5. Remove coupling flange with the help of puller</li> <li>6. Remove coupling flange holder.</li> <li>7. Unscrew mounting bolts front and rear covers and take them off along with shims. Take care that oil seals are not damaged</li> <li>8. Remove spacer and Speedo drive gear.</li> <li>9. Remove circlip fitted on drive shaft with the help of circlip pliers.</li> <li>10. Remove snap ring from drive shaft bearing. Mount puller on snap ring groove. Tighten two screws on the puller uniformly till bearing comes out from its seat.</li> <li>11. Similarly pull out main shaft bearing.</li> <li>12. Tap counter shaft assembly from both ends in turn and remove outer races of its taper rollers.</li> <li>13. Push counter shaft towards rear and lower it down slowly in the housing.</li> <li>14. Take out drive shaft from front side and pick out 5th speed synchro cone.</li> <li>15. Lift main shaft assembly from front end and take it out from the gear box.</li> <li>16. Put identification marks on front and rear end bearings if four point ball bearings are used bearing races should not be inter changed while reassembling.</li> </ol>

		<ol style="list-style-type: none"> <li>17. Pull out reverse idler gear shaft from housing by using puller.</li> <li>18. Pick out reverse gear assembly.</li> <li>19. Remove reverse gear intermediate lever along with its sliding key</li> <li>20. Take out counter shaft assembly from gear box housing.</li> <li>21. Remove gear box housing from work stand, clean it and keep it aside</li> </ol>
3	Dismantling of main shaft	<ol style="list-style-type: none"> <li>1. Remove circlip, pull out assembly engaging gear 4<sup>th</sup>/5<sup>th</sup> speed and 4<sup>th</sup> speed gear with its needle cage and synchro cones.</li> <li>2. Mount holder on the 3<sup>rd</sup> speed gear .with the help of puller and its spacer remove 3<sup>rd</sup> speed gear along with 4<sup>th</sup> speed collar bush pick out 3<sup>rd</sup> speed needle cage and synchro cone.</li> <li>3. Remove circlip, pull out assembly engaging gear 2<sup>nd</sup> /3<sup>rd</sup> speed with shifter sleeve and 2<sup>nd</sup> gear with its needle cage.</li> <li>4. Reverse the main shaft.</li> <li>5. Mount the puller with its spacer and pull out reverse gear along with spacer ring, inner races (if four point ball bearing fitted )and assembly engaging gear 1<sup>st</sup>/reverse speed with shifter sleeve.</li> <li>6. Take out 1<sup>st</sup> speed gear with synchro cone and needle cage.</li> <li>7. Dismantle carefully the synchro gear sets assemblies. Ensure that ball pins and springs do not fly off.</li> </ol>
4	Inspection of parts	<ol style="list-style-type: none"> <li>1. Clean and inspect all the parts for wear and damage.</li> <li>2. Replace all the damaged and worn out parts.</li> </ol>
5	Sub-Assembly of Synchro Gears	<p><b>Reverse Gear</b></p> <ol style="list-style-type: none"> <li>1. Keep the reverse gear such that its synchro ring teeth are upward.</li> <li>2. Assemble ball pin (3 nos.) in the carriers. Locate them in the slots in the reverse gear along with spring.</li> <li>3. Press carriers and slide the shifter sleeve over its splines till carriers ball pins locate in the undercut.</li> <li>4. 2<sup>nd</sup>/3<sup>rd</sup> SPEED ENGAGING GEAR</li> <li>5. Keep engaging gear 2<sup>nd</sup>/3<sup>rd</sup> speed on the table.</li> <li>6. Assemble ball pins (3 nos.) in their carriers. Locate them in the slots in the engaging gear – body along with springs.</li> <li>7. Press carriers and slide the shifter sleeve over its splines till carriers ball pins locate in the undercut</li> </ol>

6	4 <sup>th</sup> /5 <sup>th</sup> Speed Engaging Gear	<ol style="list-style-type: none"> <li>1. Locate spring ring on both sides of the engaging gear such that its bend is towards groove.</li> <li>2. The offset end of one spring ring and the free end of other spring ring wire should rest against the same carriers.</li> <li>3. Mount and press three carriers in the slots provide in the engaging gear body.</li> <li>4. Slide shifter sleeve over the engaging gear, with its step facing the 4<sup>th</sup> speed gear, till the carriers are located in its undercut</li> </ol>
7	Sub Assembly of Main Shaft	<ol style="list-style-type: none"> <li>1. Hold the main shaft vertically such that coupling flange and faces upwards</li> <li>2. Insert 1<sup>st</sup> speed gear (38 teeth) along with its needle cage such that synchro ring teeth face upwards. Oil the needle cage before fitment.</li> <li>3. Locate synchro cone on the first gear and install sub – assembly reverse gear</li> <li>4. Insert spacer ring of maximum thickness and install bearing with snap ring with the help of drift.</li> <li>5. To maintain correct spacings of shifter sleeves in the gearbox, it is very important to adjust dimension 95+0.04mm from front face of collar on the main shaft to inner face of bearing snap ring. This can checked by the checking gauge .If the gauge does not fit snugly, remove bearing and spacer. Fit another spacer as required. The spacer is available in seventeen thicknesses from 6.65mm to 7.45mm in steps of 0.05 mm. Check the distance with gauge and repeat the cycle till the proper assembly is achieved.</li> <li>6. Insert Speedo drive gear, spacer and coupling flange. Tighten hex nut to specified torque.</li> <li>7. Reverse the main shaft.</li> <li>8. Oil needle cage and slide it along with the 2<sup>nd</sup> speed gear (32 teeth) keeping synchro ring gear teeth upward.</li> <li>9. Locate synchro cones for 2<sup>nd</sup>/3<sup>rd</sup> speed gear in its engaging gear assembly and install it over the main shaft such that longer hub is upward.</li> <li>10. Select and install a circlip so that the circlip sits snugly without any axial play. The circlip are available in thicknesses of 2.50, 2.54, 2.58, 2.62 and 2.66</li> <li>11. Oil needle cage and slide it along with the 3<sup>rd</sup> speed gear (23 teeth). Keep synchro ring gear teeth towards 2<sup>nd</sup> speed gear.</li> <li>12. Heat the collar bush in hot oil (temperature 80°C) for 30 minutes. Press the collar bush, keeping flange towards 3<sup>rd</sup> speed gear, with the help of drift.</li> <li>13. Oil needle cage and slide it along with the 4<sup>th</sup> speed gear</li> </ol>

		<p>keeping synchro ring gear teeth upward</p> <ol style="list-style-type: none"> <li>14. Locate synchro cones and install engaging gear assembly 4<sup>th</sup>/5<sup>th</sup> speed gear such that step is towards 4<sup>th</sup> speed gear.</li> <li>15. Install circlip so that it fits snugly without any axial play. The circlip are available in the thickness of 2.46, 2.50, 2.54, 2.58, 2.62 and 2.66 mm.</li> <li>16. Remove snap ring from outer race of main shaft bearing</li> <li>17. Remove main shaft bearing with the help of puller. (If 4 point ball bearing is used, do not remove inner race</li> </ol>
8	Disassembly of Counter Shaft	<ol style="list-style-type: none"> <li>1. Mark inner races of both tapered roller bearings prior to their removal from the counter shaft, as the position of the inner races should not be changed during reassembly.</li> <li>2. Remove inner races with the help of puller.</li> <li>3. Remove circlip</li> <li>4. Take out constant mesh gear and 4<sup>th</sup> speed gear by pressing the counter shaft</li> </ol>
9	Inspection of Countershaft Components	<ol style="list-style-type: none"> <li>1. Clean and inspect the condition of keys, circlip, bearing and gears if damaged change the parts.</li> </ol>
10	Sub Assembly of Counter Shaft	<ol style="list-style-type: none"> <li>1. Place constant mesh gear (37 teeth) and 4<sup>th</sup> speed gear (33 teeth) in hot oil (temperature 80°C) for about 30 minutes.</li> <li>2. Press the 4<sup>th</sup> speed gear (33 teeth) and constant mesh gear.</li> <li>3. Press inner races of both taper roller bearings with the help of drift.</li> </ol>
11	Disassembly of Drive Shaft	<ol style="list-style-type: none"> <li>1. Take out inner race of 4 point ball bearing if fitted</li> </ol>
12	Sub-Assembly of Drive Shaft	<ol style="list-style-type: none"> <li>1. Press the inner race of 4 point ball bearing, if fitted, with the help of drift,</li> <li>2. Oil the needle roller cage and insert it in the drive shaft.</li> <li>3. Locate the 5<sup>th</sup> speed synchro cone on the drive shaft</li> </ol>
13	Disassembly of Reverse Idler Gear	<ol style="list-style-type: none"> <li>1. Remove circlip</li> <li>2. Take out spacer</li> <li>3. Take out needle cages</li> </ol>
14	Inspection	<ol style="list-style-type: none"> <li>1. Ensure that circlips and needle rollers and cages are not damaged. If so, change the damaged component</li> </ol>
15	Sub-assembly of Reverse Idler Gear	<ol style="list-style-type: none"> <li>1. Fit circlip at one end of the gear bore.</li> <li>2. Slide spacer at the other end of bore till it rests on the circlip.</li> <li>3. Oil needle roller cages and slid them one after another in the bore.</li> <li>4. Place the second spacer.</li> <li>5. Fit second circlip in to the slot provided in the bore.</li> </ol>

16	Disassembly of Gear Cover	<ol style="list-style-type: none"> <li>1. Press out oil seal from the rear of cover, if damaged.</li> <li>2. Knock out plug from the end of speedo shaft using screw driver.</li> <li>3. Unscrew threaded bush and press out the speedometer shaft Fig.30.</li> <li>4. Remove small drive gear</li> </ol>
17	Inspection	<ol style="list-style-type: none"> <li>1. Clean and inspect the parts. Replace them if required.</li> </ol>
18	Sub-Assembly of Rear Cover	<ol style="list-style-type: none"> <li>1. Place the small drive gear in position and press its shaft in through the housing and then into the gear.</li> <li>2. Screw – in the threaded bush.</li> <li>3. Press – in the plug at the end.</li> <li>4. Fit oil seal into the cover with the help of drift,</li> </ol>
19	Disassembly of Front Cover	<ol style="list-style-type: none"> <li>1. Remove the oil seal, if damaged.</li> </ol>
20	Inspection	<ol style="list-style-type: none"> <li>1. Clean and inspect, replace if necessary.</li> </ol>
	Sub-Assembly of Front Cover	<ol style="list-style-type: none"> <li>1. Press the oil seal with the help of drift</li> </ol>
21	Disassembly of Top Cover Note: Before dismantling keep all the shifting forks in neutral position only.	<ol style="list-style-type: none"> <li>1. Unscrew the breather assembly and remove it.</li> <li>2. Remove front and rear caps from each shifter shaft</li> <li>3. Push out with the help of cylindrical punch, dowel sleeves.</li> <li>4. Remove circlip from 4<sup>th</sup>/5<sup>th</sup> speed shifter shaft.</li> <li>5. Push out 4<sup>th</sup>/5<sup>th</sup> speed shifter shaft with the help of a suitable pin. Keep spacer, spring and balls carefully.</li> <li>6. Push out 2<sup>nd</sup>/3<sup>rd</sup> speed shifter shaft, with the help of a suitable pin. Keep shifter dog, spring, needle and balls carefully.</li> <li>7. Push out from the front end first speed shifter shaft while holding its circlip opened with the help of a circlippliers Keep pin, balls, springs, needle, circlip and spacer carefully.</li> <li>8. Push out the reverse shifter shaft from rear end, holding the circlip opened with the help of a circlippliers. Keep reverse fork, balls and circlip carefully.</li> </ol>
22	Inspection	<ol style="list-style-type: none"> <li>1. Clean the parts and inspect for damage and unusual wear. Change the excessive worn out or damaged parts.</li> </ol>
23	Sub-Assembly of Top Cover	<ol style="list-style-type: none"> <li>1. Insert spring into the shifter dog (reverse and 1<sup>st</sup> speed)</li> <li>2. Insert plunger over the spring, press it fully, and fit circlip at other end of plunger.</li> <li>3. Insert 6mm dia ball through hole on other side, push spring and lock it with a new dowel sleeve across the spring.</li> <li>4. Place the top cover, facing gasket surface upward, over</li> </ol>

		<p>the work bench by suitably supporting from underneath.</p> <ol style="list-style-type: none"> <li>5. Insert hard spring through the boss side – hole provided in the mid rib of “over and one soft spring in each remaining 3 holes.</li> <li>6. Insert one smaller spring in all the 4 holes.</li> <li>7. Insert 9mm dia ball one each in all the four holes at the time of pushing shifter shaft.</li> <li>8. Insert shifter shaft (reverse speed) from front/boss end through shifter dog (separately assembled earlier) kept in 1<sup>st</sup> pocket such that its slot is downward circlip, push shaft further , place intermediate lever (reverse speed) in 3<sup>rd</sup> pocket and, push the shifter shaft fully.</li> <li>9. Insert 12 mm dia ball inside the other bore of shifter dog, one 12 mm dia ball in the next hole of cover, push 1<sup>st</sup> speed shifter shaft fix circlip, push shifter shaft through dog, place thinner spacer and shifter fork. Keeping its dowel towards rear push the shifter shaft through the fork, insert needle roller in the front end and push the shifter shaft fully.</li> <li>10. Insert 12 mm dia ball in third hole of cover, push 2<sup>nd</sup>/3<sup>rd</sup> speed shifter shaft, place 2<sup>nd</sup>/3<sup>rd</sup> speed dog in first pocket keeping slot downward and cut portion towards front, place shifter fork in second pocket with its hole facing front end of cover , insert needle roller in the front end of shifter shaft and push it fully.</li> <li>11. Insert ball in fourth hole of cover push in the shifter shaft 4<sup>th</sup>/5<sup>th</sup> speed, place fork in first pocket such that its cut portion faces towards front of cover , push shifter shaft further, place wider spacer in first pocket and push the shifter shaft fully .Fix circlip over shifter shaft</li> <li>12. Press the new dowel sleeves in all the places.</li> <li>13. Apply ‘maxfix’ and press all the end caps into the cover.</li> <li>14. Press solid plugs, one into the hole near breather on cover and another into the cover towards 4<sup>th</sup>/5<sup>th</sup> speed shifter shaft.</li> <li>15. Fix breather</li> <li>16. Apply shellac and fix gasket</li> </ol>
24	Disassembly of Gear Shift Lever	<ol style="list-style-type: none"> <li>1. Unscrew the gear shift lever knob after loosening check nut.</li> <li>2. Slide the rubber below up and take it out.</li> <li>3. Remove cap (gear shift dome)</li> <li>4. Remove ball piece (gear shift dome)</li> <li>5. Remove pressure spring</li> </ol>
25	Inspection	<ol style="list-style-type: none"> <li>1. Clean and inspect parts if damaged change the parts</li> </ol>

26	Sub-Assembly of Gear Shift Lever	<ol style="list-style-type: none"> <li>1. Insert pressure spring over the gear shift lever</li> <li>2. Fix ball piece (gear shift dome) over the gear shift lever</li> <li>3. Install cap (gear shift dome) over the gear shift lever</li> <li>4. Insert rubber below over the gear shift lever</li> <li>5. Screw in gear shift lever knob and tighten the check nut</li> </ol>
27	Selection of Shims for Counter Shaft/Front Cover	<ol style="list-style-type: none"> <li>1. Install counter shaft sub – assembly in gear box</li> <li>2. Fit rear cover with gasket</li> <li>3. Tap counter shaft front bearing towards rear. Measure protrusion of the outer race of front taper roller bearing of the counter shaft from gear box housing machined surface. Let this dimension be ‘A’. Stick the gasket on the front cover with shellac. Measure the bearing bore depth of the front cover from the gasket face. Let this dimension be ‘B’. Select and fit shim/shims of thickness ‘C’, so that on assembly the axial play on the counter shaft taper roller bearing is 0.02 to 0.05 mm. The shims are available in thickness of 0.05, 0.125, 0.24 and 0.50mm.</li> </ol> <p>Example:  Let A = 2.44mm, B = 2.52mm. Assume axial play to be = 0.03 mm.  Then,  <math>2.52 - (2.44 + C) = 0.03</math>  <math>2.52 - 2.44 - C - 0.03 = 0</math>  <math>C = 2.52 - 2.47 =</math>  <math>C = 0.05</math>  Therefore, add one shim of 0.05mm thick. Remove the rear cover.</p>
28	Selection of Shims Between Driveshaft & Front Cover and Main shaft Bearing & Rear Cover	<ol style="list-style-type: none"> <li>1. Select and fit snap rings of correct thickness into groove of driveshaft and main shaft bearing outer races so that snap rings fit snugly in the groove without any axial play.</li> <li>2. Snap rings are available in 6 sizes of varying in thickness from 2.68mm to 2.93mm in steps of 0.05mm.</li> <li>3. Install outer races of bearing in their respective bores in the gear box housing such that the snap ring rest on the housing face Measure projection of bearing race from the gear box housing face. Let the reading be ‘C1’ and ‘C2’ for drive shaft and main shaft bearing respectively.</li> <li>4. Measure bearing bore depth in the front /rear cover from the gasket surface. Let this distance be ‘D1’ and ‘D2’ for front and rear covers respectively.</li> <li>5. D1 – C1 and D2- C2 will indicate thicknesses of the shims required for driveshaft and main shaft bearings respectively for no load/no play condition.</li> </ol>

		<ol style="list-style-type: none"> <li>6. Select and fit shims such that the axial play on drive shaft/main shaft is 0.02 to 0.05 mm.</li> <li>7. Shims are available in thicknesses of 0.05, 0.1, 0.2, 0.4 and 0.8mm</li> </ol>
29	Assembly of Gear Box	<ol style="list-style-type: none"> <li>1. Mount gear box housing, after cleaning it thoroughly, on work stand.</li> <li>2. Lower Mount counter shaft assembly into the housing and rest in down slowly.</li> <li>3. Hold the intermediate lever, with the sliding key in its position, in the housing. Lubricate pivot pin and screw it in the housing locating the intermediate level. Tighten the pivot pin</li> <li>4. Fit reverse idler gear, with its shifting groove facing front, to the gear box housing. Lubricate and press the reverse gear shaft into the gear box housing through the reverse idler gear keeping the slotted end of the reverse idler gear shaft towards the rear. Ensure that the slot in the shaft is in vertical position with the cut out in the left.</li> <li>5. Insert main shaft assembly into the housing</li> <li>6. Locate drive shaft assembly over main shaft</li> <li>7. Lift drive shaft and main shaft assemblies</li> <li>8. Lift the counter shaft assembly align it and installs outer races of taper roller bearings with drift.</li> <li>9. Install the drive shaft and main shaft SRDG ball bearing along with snap ring or 4 point ball bearing set such that snap ring bolts against housing machined surfaces. Fig 58.</li> <li>10. Slide the speedo drive gear, such that smaller diameter face is toward ball bearing, and fit spacer over the main shaft. . Fit the rear cover assembly with its preselected shims. Tighten mounting screws with spring washer</li> <li>11. Fit coupling flange and new hex nut. Mount holder on the coupling flange. Tighten the nut to 28 – 32 mkg with the help of 36 mm socket and torque wrench Engage reverse gear</li> <li>12. Install the circlip such that it snugly fits in the groove. The circlip is available in size of 2.1, 2.2, 2.3, 2.4 and 2.5 mm thickness</li> <li>13. Remove coupling flange holder and disengage the gear Install front cover assembly with its preselected shim and tighten its mounting screws along with spring washer.</li> </ol> <p><b>Note:</b> In case front cover or rear cover mounting screws are changed ensures that none of the screws touch the gears inside the housing.</p> <ol style="list-style-type: none"> <li>14. Mount the top cover assembly with its gasket in</li> </ol>

		<p>position and screw in the cover bolts</p> <ol style="list-style-type: none"><li>15. Remove, clean and refit drain plug</li><li>16. Fix the gear shift lever assembly, keeping bend of lever facing towards oil filling plug, on the cover assembly.</li><li>17. Check and ensure that the gear shift is smooth</li><li>18. Remove gear shift lever assembly before mounting the gear box on the vehicle</li><li>19. Check and ensure that the gear shift is smooth</li></ol>
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## C. Repair Transfer Case

S.N.	Assignment	Skill
1	Removal of Transfer Case from vehicle	<ul style="list-style-type: none"> <li>• Loosen drain plug, drain out oil in a tray and fix plug back.</li> <li>• Disconnect gear shift lever from transfer case.</li> <li>• Disconnect speedo cable and hook it suitably.</li> <li>• Unlock and loosen coupling flange bolts and disconnect front axle, rear axle and gear box end propeller shafts.</li> <li>• Support the transfer case suitably, loosen mounting bolts and remove Plummer blocks.</li> <li>• Lower the transfer case and take it out.</li> <li>• Clean the transfer case from outside.</li> <li>• Keep it on work bench or mount on suitable stand.</li> </ul>
2	Dismantling of transfer case assembly	<ul style="list-style-type: none"> <li>• Remove breather.</li> <li>• Un-stake hex nut, holding the coupling flange.</li> <li>• Fix holding device over the coupling flange of RA and FA output shafts in succession.</li> <li>• Loosen the nut using a socket.</li> <li>• Pull out all three flanges one after other in the same sequence using puller.</li> <li>• Loosen bolts and remove rear cover (top) along with oil seal, bearing and shims.</li> <li>• Gently tap with mallet.</li> <li>• Take out thicker spacer, speedo meter drive gear and thin spacer using puller.</li> <li>• Loosen bolts and remove cover from guide shaft.</li> <li>• Loosen bolts and remove rear cover (Bottom) along with shims.</li> <li>• Loosen bolts and take out flange along with sealing shim (gasket), intermediate ring, sealing ring and sleeve shifter shaft (rubber boot) from shifter shaft.</li> <li>• Un stake intermediate shaft nut and remove using socket.</li> <li>• Take out spacer.</li> <li>• Loosen all bolts of transfer case cover.</li> <li>• Remove it by suitably tapping it along with outer race of taper roller bearing.</li> <li>• Take out output shaft rear along with outer race of taper roller bearing and inner race of taper roller bearing (rear axle output).</li> <li>• Push out guide shaft and remove output shaft assembly along with shifter fork (bottom), spacer from the housing.</li> <li>• Unlock locking plate.</li> <li>• Press out intermediate shaft by hammering at threaded</li> </ul>

		<p>end and take out spacer and inner races of bearing along with double gear.</p> <ul style="list-style-type: none"> <li>• Use proper type of hammer so that edge of the shaft is not damaged.</li> <li>• Loosen with screw driver sealing plug of shifter shaft locking arrangement and remove spring and ball</li> <li>• Take out drive assembly along with synchro assembly, shifter sleeve spacers and bearing inner race, spacer.</li> <li>• Remove split pin from shifter lever bearing pin and loosen the castle nut.</li> <li>• Take out bearing pin from the housing.</li> <li>• Remove shifter lever assembly from the housing.</li> <li>• Remove drive shaft assembly along with shifter fork assembly.</li> <li>• Remove oil seals from drive shaft and front axle ends.</li> <li>• Remove oil filling plug.</li> <li>• Unscrew magnetic drain plug and remove it.</li> </ul>
3	Dismantling of sub - assemblies	<p><u>Output shaft (rear axle end)</u></p> <ul style="list-style-type: none"> <li>• Take out spacer and press out the inner race of taper roller bearing (large) by using a suitable punch.</li> <li>• Remove outer race of taper roller bearing (small) by hammering with a suitable pin inserted through holes provided in the helical gear.</li> </ul> <p><u>Drive shaft assembly (gear box to transfer case )</u></p> <ul style="list-style-type: none"> <li>• Remove synchro cone align the teeth of shifter sleeve with those of helical gear and gently push synchro sleeve out of three retention pins, so that the retention pins and compression springs do not jump off.</li> <li>• Take out large taper roller bearing inner race with help of puller along with spacer and helical gear.</li> <li>• Take out needle roller cage along with synchro sleeve and synchro cone.</li> <li>• Remove small taper roller bearing inner race with the help of puller.</li> </ul> <p><u>Output shaft (front axle)</u></p> <ul style="list-style-type: none"> <li>• Press out taper roller bearing big inner race after holding suitably along with spacer and output gear (front axle)</li> <li>• With the help of puller.(Alternatively on press)and separate it out.</li> <li>• Take out spacer and output gear (helical)</li> <li>• Take out needle roller cage.</li> <li>• Take out shifter sleeve.</li> <li>• Remove taper roller bearing inner race (spline end) with the help of puller.</li> </ul> <p><u>Intermediate shaft double gear</u></p> <ul style="list-style-type: none"> <li>• Remove circlip</li> </ul>

		<ul style="list-style-type: none"> <li>• Push out smaller outer race from double gear by using suitable drift.</li> <li>• Similarly remove outer race from double gear by pushing through hole using suitable pin.</li> </ul> <p><u>Shifter lever assembly</u></p> <ul style="list-style-type: none"> <li>• Push out bush from the lever.</li> <li>• Take out split pin and remove bearing pin.</li> <li>• Remove tension spring hook and separate lever.</li> <li>• Shifter shaft and shifter fork (upper)</li> <li>• Push out dowel sleeve and take out fork from shaft.</li> <li>• Flange with sleeve shifter shaft (rubber boot)</li> <li>• Remove spring ring and separate rubber sleeve.</li> <li>• Take out sealing ring and intermediate ring.</li> </ul> <p>Rear cover top.</p> <ul style="list-style-type: none"> <li>• Remove assembly threaded bush.</li> <li>• Push out shaft ( speedometer drive)</li> <li>• Take out small drive gear.</li> <li>• Remove oil seal along with bearing using drift.</li> </ul> <p>Taper roller bearing outer race in the housing and cover</p> <ul style="list-style-type: none"> <li>• Take out outer races from (drive shaft and front axle output) front transfer case housing using drifts with handle and take out both oil seals.</li> <li>• Take out outer races from transfer case rear cover using drift and handle for drift.</li> </ul> <p>Inspection and general instructions.</p> <ul style="list-style-type: none"> <li>• Clean all the parts to be assembled thoroughly.</li> <li>• Clean and lubricate the shafts thoroughly before assembling oil seal. Maintain proper cleanliness while assembling bearings and oil seals to avoid premature failure.</li> </ul> <p><u>Check</u></p> <ul style="list-style-type: none"> <li>• Shaft for scoring and grooving.</li> <li>• Gear for chipped teeth</li> <li>• Bushes for wear and cracks</li> <li>• Bearing for wear and cracks.</li> <li>• Change worn out and damaged parts.</li> <li>• Oil seal and gaskets should be changed at the time of overhaul.</li> <li>• Pay attention to the direction of oil seal and insert all the way after applying oil to the lips.</li> <li>• Do not reuse dowel sleeve.</li> <li>• Synchro clearance to be checked, replace synchrocones, if found less or if the threads are found to be damaged.</li> <li>• Smear bearing seat on the shaft with multipurpose grease before fitting bearings.</li> <li>• Circlip should not have axial play.</li> </ul>
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		<ul style="list-style-type: none"> <li>• Spin shafts to see the gears are running smoothly.</li> <li>• Use sealing compound for all fasteners.</li> <li>• The chips collected by magnetic drain plug should be removed.</li> <li>• Stake nut wherever provided originally.</li> <li>• Engaging gear should be free from play.</li> <li>• Do not inter change the needle roller cages, and inner and outer races of taper roller bearings.</li> </ul>
4	<p>Assembly of transfer case and Assembly of sub-assemblies</p>	<p><u>Output shaft (rear axle end)</u></p> <ul style="list-style-type: none"> <li>• Press the taper roller bearing outer race on the dog teeth side of output shaft with the help of drift with handle.</li> <li>• Reverse the output shaft and press inner race of the large taper roller bearing on the shaft end with the help of drift.</li> </ul> <p><u>Drive shaft (gear box to transfer case)</u></p> <ul style="list-style-type: none"> <li>• Press inner race of taper roller bearing keeping bigger diameter end downwards with the help of drift.</li> <li>• Keep the drive shaft vertically on bench such that threaded end is faces upwards.</li> <li>• Slide synchro sleeve over the drive shaft keeping the collar side upwards.</li> <li>• Place synchro cone keeping collar side downwards, such that cones stopper is aligned with slot without hole insynchro sleeve.</li> <li>• Slide needle roller cage assembly over synchro sleeve.</li> <li>• Slide helical gear keeping dog teeth end downward.</li> <li>• Insert spacer input shaft.</li> <li>• Reverse the assembly and press the inner race of small taper roller bearing keeping larger diameter end downward with the help of drift.</li> <li>• Insert carrier compression spring and retention pins in to the recess of shifter sleeve. Align the shifter sleeve with the retention pins .press any two retention pins simultaneously and push the shifter sleeve down in such a way that the pin come inside a little and then press third pin inward keeping shifter sleeve pressed with one hand and push it down as soon as third pin also comes inside.</li> <li>• Place the synchro cone properly.</li> </ul> <p><u>Output shaft (front axle )</u></p> <ul style="list-style-type: none"> <li>• Keep output shaft in vertical position with spline end upward.</li> <li>• Press inner race of taper roller bearing with the help of drift</li> <li>• Reverse the shaft and hold it suitably.</li> <li>• Slide shifter sleeve over engaging gear.</li> <li>• Slide the output gear (front axle) along with needle roller cage over the output shaft (front axle) such that dog teeth</li> </ul>

		<p>face towards engaging gears.</p> <ul style="list-style-type: none"> <li>• Press spacer over gear with the help of drift.</li> <li>• Press inner race of taper roller bearing with the help of drift.</li> </ul> <p><u>Intermediate shaft</u></p> <ul style="list-style-type: none"> <li>• Keep double gear with smaller gear facing upward and insert circlip. Press taper roller bearing outer race using drift and handle.</li> <li>• Reverse double gear and press outer race of taper roller bearing using drift and handle.</li> </ul> <p><u>Shifter lever assembly</u></p> <ul style="list-style-type: none"> <li>• Place shifter lever (lower) inside the shifter lever (upper) properly.</li> <li>• Anchor the tension spring.</li> <li>• Insert pin from the plain surface end</li> <li>• Place washer and fix split pin.</li> <li>• Press the bush inside.</li> </ul> <p><u>Shifter shaft and shifter fork.(upper)</u></p> <ul style="list-style-type: none"> <li>• Place shifter shaft inside the upper shifter fork and insert dowel sleeve.</li> </ul> <p><u>Flange with sleeve shifter shaft (upper) .</u></p> <ul style="list-style-type: none"> <li>• Insert the sealing ring and intermediate ring inside the flange.</li> <li>• Place sleeve (Rubber boot) over flange and clamp it with spring using proper tool.</li> </ul> <p><u>Transfer case cover</u></p> <ul style="list-style-type: none"> <li>• Support the cover properly.</li> <li>• Press in outer races of taper roller bearings at two places using drift and handle.</li> <li>• Place gasket after applying shellac over cover.</li> </ul> <p><u>Rear cover( top)</u></p> <ul style="list-style-type: none"> <li>• Place small drive gear inside.</li> <li>• Push in speedo meter drive shaft keeping the step side at threaded end (projection of step 10 mm).</li> <li>• Screw in threaded bush. Replace rotary shaft seal if damaged.</li> <li>• Insert plug.</li> <li>• Press ball bearing using drift.</li> </ul>
5	Transfer case assembly	<ul style="list-style-type: none"> <li>• Press taper roller bearing outer race at drive shaft and output shaft (front axle) bores in housing using drift.</li> <li>• Press intermediate shaft from rear end of transfer case housing.</li> <li>• Fix lock plate over intermediate shaft.</li> <li>• Assemble bearing and inner races with rollers on double gear assembly (intermediate shaft) and measure distance between outer surfaces of bearings say it is A .measure</li> </ul>

		<p>width of outer of bearing (1) and length of spacer (2) and all three dimension say B.</p> <ul style="list-style-type: none"> <li>• Calculate A-B and select shim such that when assembled in transfer case, bearings are preloaded between 0.03mm to 0.05 mm</li> <li>• Press inner race of taper roller bearing keeping larger diameter towards housing bottom with the help of drift.</li> <li>• Insert drive shaft assembly along with sub- assembly of shifter shaft shifter fork keeping small end downward.</li> <li>• Locate the shifter assembly, in shifter fork slots such that shifter lever (upper half) is towards the drive shaft.</li> <li>• Insert bearing pin from inside the housing through bush such that the threaded end goes outside.</li> <li>• Tighten the castle nut and fix the split pin.</li> <li>• Insert spacer over intermediate shaft such that big chamfer end remain towards the cover side.</li> <li>• Place shim as selected in paragraph above.</li> <li>• Insert double gear by lifting the drive shaft assembly upward and tilting the double gear such that bigger dia gear is towards housing.</li> <li>• Press inner race of taper roller bearing keeping smaller dia meter towards housing using drift.</li> <li>• Insert spacer over intermediate shaft.</li> <li>• Insert sub-assembly of output shaft ((front axle) keeping the spline end downward along with shifter fork (bottom) such that slot of fork is aligned with shorter lever.</li> <li>• Insert guide shaft through fork.</li> <li>• Place output shaft (rear axle) sub-assembly .over the drive shaft assembly such that spline end of shaft remains upwards/open end of housing.</li> <li>• Mount transfer case cover on housing.</li> <li>• Tighten the bolts along with washers.</li> <li>• Insert caps on shifter shafts.</li> <li>• Place spacer over intermediate shaft and tighten hex nut.</li> <li>• Place spacer on output shaft (rear axle).</li> <li>• Insert speedo meter drive gear such that collar end faces the bearing.</li> <li>• Push spacer such that tapered end faces towards spline end.</li> </ul>
6	Check the axial play at output shaft.	<p>Measure the protrusion of outer race of bearing from transfer case cover. Let this dimension be X .measure depth of step from outer face of rear cover (top) after placing gasket on it. Let this dimension be Y. select shims in such a way that X is more than Y plus shim thick ness by 0.03to 0.05 mm. this will ensure proper pre loading .shims are available in various thickness . Place rear covers assembly (top) and tighten bolts. Use drift for assembly of oil seals.</p>

		<p>Press coupling flange and tighten the hex nut to specified torque.  Use holding device to tighten the hex nut.  Stake the nut over shaft.</p> <p><u>Inspection</u></p> <ul style="list-style-type: none"> <li>• Check the axial play at rear cover.(bottom)</li> <li>• Measure the protrusion of outer race of bearing from transfer case cover. Let this dimension be X Measure the depth of step from outer face rear cover (bottom) after placing gasket on it.</li> <li>• Let this dimension be Y .select shims in such a way that shim thickness =<math>(X-Y) - (0.03 \text{ to } 0.05\text{mm})</math>.place shim in rear cover (bottom) .this will ensure proper axial play. Shims are available in various thickness.</li> <li>• Place the rear cover bottom with preselected shims and new gasket fixed on cover with shellac.</li> <li>• Tighten bolts.</li> <li>• Fix cover with gasket by bolts provided over housing</li> <li>• Reverse the transfer case assembly.</li> <li>• Place the spacer over drive shaft.</li> <li>• Press oil seal .use drift.</li> <li>• Press coupling flange and tighten hex nut to specified torque. Use holding device to tighten coupling flange.</li> <li>• Stake the nut over the shaft.</li> <li>• Insert spacer over output shaft (front axle) press the seal. Use drift for assembling oil seal.</li> <li>• Place coupling flange and tighten the hex nut to specified torque. Use holding device to tighten coupling flange.</li> <li>• Stake the nut.</li> <li>• Fit flange with sleeve shifter shaft sub assembly along with gasket after applying shellac and tighten bolts.</li> <li>• Insert the balls and compression springs in proper place for shifter locking and tighten sealing plug.</li> <li>• Fix spacer, rubber bellows, washer and circlip at the ends of mounting pins.</li> <li>• Tighten the drain plug.</li> <li>• Fill specified quantity of specified oil and fix plug and breather.</li> </ul>
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#### D. REAR AXLE & FINAL DRIVE

S.N	Assignment	Skill
1	REMOVAL AND INSTALLATION OF REAR AXLE FROM VEHICLE	<p><b><u>Removal</u></b></p> <ul style="list-style-type: none"> <li>• Place suitable wheel chock on front and behind the front wheels.</li> <li>• Remove the drain plug and drain lubricating oil. Clean and refit drain plug.</li> <li>• Disconnect the propeller shaft from tail pinion flange and lay it on the side.</li> <li>• Remove split pins and disconnect hand brake from its lever on chassis cross member.</li> <li>• Unscrew rear brake hose from three way union on the rear axle. Plug the openings to avoid oil and entry of dirt.</li> <li>• Loosen rear wheel nuts slightly and lift rear axle assembly by jacks, so that wheels are lifted the ground. Support chassis frame suitably.</li> </ul> <p style="text-align: center;"><u>Note:</u> Never place the jack under the rear axle Centre housing but only beneath spring seat especially on a loaded vehicle.</p> <ul style="list-style-type: none"> <li>• Unscrew U bolt check nuts and nuts and knock out U bolts with mallet .Remove U bolt guide plate.</li> <li>• Lower and roll out rear axle assembly with rear wheel from beneath the chassis towards the rear. Care should be taken to prevent tail pinion flange from getting damage during removal.</li> <li>• With suitable lifting arrangement position rear axle assembly on the work stand.</li> </ul> <p><b><u>Installation</u></b></p> <ul style="list-style-type: none"> <li>• Place axle assembly with wheels below the springs such that springs Centre bolts align in their holes in the spring seats.</li> <li>• Clean U bolts. Ease threads before fitting and oil the threads. Check threads of U bolts and nuts for cracks or any damage .Replace damage d parts, if any</li> <li>• Mount U bolts and tighten the U bolt nuts and check nuts to specified torque.</li> <li>• Clean the area around the filler plug and fill rear axle with recommended oil up to filler plug level.</li> </ul>

		<ul style="list-style-type: none"> <li>• Tighten wheel mounting nuts to specified torque.</li> <li>• Position and fasten propeller shaft to the coupling flange with nuts lock plates and bolts. Tighten the mounting bolts to specified torque and lock the bolt heads with lock plates.</li> <li>• Connect and tighten brake hose to the three way union.</li> <li>• Top up brake fluid container and bleed the braking system.</li> <li>• Connect hand brake cables to their respective ends of the lever on chassis cross member .insert washer on the headed pins and put split pins.</li> <li>• Adjust brake.</li> <li>• Road test vehicle.</li> </ul> <p><b><u>Removal of axle shaft.</u></b></p> <ul style="list-style-type: none"> <li>• Unscrew axle shaft lock nuts and nuts.</li> <li>• Using screw driver pull out axle shafts from the hubs.</li> </ul>
2	REMOVAL OF CROWN WHEEL, DIFFERENTIAL ASSEMBLY AND TAIL PINION ASSEMBLY	<ul style="list-style-type: none"> <li>• Unscrew and remove rear cover &amp; stiffener from the rear axle center housing</li> <li>• Unlock the tab washers and remove the bolts of the differential bearing cap threaded ring lock plates</li> <li>• Unscrew bolts holding differential side bearing caps (the side bearing caps are marked ‘L’ &amp; ‘R’ for left and right respectively) and remove bearing caps. Do not interchange side bearing caps of different assemblies</li> <li>• Remove the threaded adjusting rings on the left and right of the differential taper roller bearings</li> <li>• Remove carefully the outer races of the differential taper roller bearings and put identification marks. These should not be interchanged</li> <li>• Tilt crown wheel with differential assembly to the right from the top till the crown wheel align with the recesses provided in the housing and remove the assembly out.</li> <li>• Turn the axle through 180° and lock in position, such that the tail pinion coupling flange is facing upwards</li> <li>• Unlock the tab washer, unscrew the bolts holding lock plate of the tail pinion threaded ring and remove the lock plate</li> <li>• Un-stake coupling flange nut</li> <li>• Clamp down two halves of pronged wrench to the coupling flange using M8X30 mm long screw and</li> </ul>

		<p>nuts.</p> <ul style="list-style-type: none"> <li>• Unscrew threaded ring fully using torque multiplier (ratio 1:4) holder and torque wrench</li> <li>• Tighten 2 M8 screw holding pronged wrench to coupling flange fully. With this the split spacer ring will be held tight between outer races of tail pinion taper roller bearing.</li> <li>• Screw in 2 M10 special long screw in the pronged wrench collar. Tighten them uniformly till tail pinion assembly is released from its housing</li> <li>• Remove tail pinion depth adjusting shims from the housing</li> <li>• Using drift remove tail pinion cylindrical roller bearing outer race..</li> </ul>
3	DISMANTLING OF TAIL PINION	<ul style="list-style-type: none"> <li>• Mount holder on the coupling flange. Grip the holder in a vice and unscrew the nut with socket using puller extract coupling flange</li> <li>• Using commercial puller or press and support ring extract taper roller bearing.</li> <li>• Put identification marks on inner and outer races of the bearings so that they will not get interchanged during reassembly</li> <li>• Remove circlip and pull out inner race of cylindrical roller bearing using universal commercial puller</li> <li>• Clean all parts thoroughly</li> </ul>
4	INSPECTION OF TAIL PINION& ITS COMPONENTS	<ul style="list-style-type: none"> <li>• Check sets number on tail pinion and crown wheel for conformity.</li> <li>• Check tail pinion and crown wheel teeth for scoring, burrs, breakages or overheating marks. Also check bearing seats on tail pinion for scoring and circlip groove for damage. Replace the pinion and crown wheel in a set, even if any one of these is found defective</li> <li>• Check splines on tail pinion. Clean all the burrs on the splines</li> <li>• Check threads on tail pinion and ease threads</li> <li>• Replace the collared nut tail pinion with a new one, since the nut once tightened and staked gets damaged due to unstaking while loosening</li> <li>• Check all bearings for signs of scoring, pitting, overheating, etc. Replace all worn/damaged bearings</li> </ul>
5	ASSEMBLY OF TAIL PINION	<ul style="list-style-type: none"> <li>• Locate chamfer on the cylindrical roller bearing inner race on the tail pinion spigot diameter. Press it in with the help of drift. Fit circlip and check for proper fit</li> </ul>

		<ul style="list-style-type: none"> <li>• Oil and keep inner race assembly of taper roller bearing on the pinion and press it in with drift. The bigger diameter of taper roller bearing should rest flush on the pinion teeth</li> <li>• Slide spacer ring on the tail pinion</li> <li>• Insert outer races of the taper roller bearing with their larger diameters on opposite end and towards their respective inner race assembly</li> <li>• Oil and keep inner race assembly of taper roller bearing on the pinion and press it in with drift. The smaller diameter of the taper roller bearing should rest flush on the spacer ring</li> <li>• Insert the thrust washer on outer bearing face.</li> <li>• Inspect tail pinion oil seal in the threaded ring for lip wear, cut or damage. If necessary, replace it using drift.</li> <li>• Fill up heavy duty molycote grease in the pocket on the oil seal between the dust lip and sealing lip and insert the assembly on tail pinion</li> <li>• Apply oil in the tail pinion and coupling flange splines. Install coupling flange on the tail pinion using drift such that it rests flush on the thrust washer.</li> <li>• Screw in new coupling flange nut on the tail pinion nut.</li> <li>• Mount holder on coupling flange and fasten it using bolts and nuts. Clamp the holder in vice .use socket and tighten the nut to specified torque.</li> <li>• Do not stake collar on nut in tail pinion at this stage.</li> <li>• Taper roller bearings of tail pinion assembly have to be assembled with the preload of 0.005 to 0.02mm to give friction moment of 5 to 20 cm kg. for preloading these bearings a spacer ring is provided between two outer races of taper roller bearings. The spacer rings are available in 16 thickness from minimum 7.26 to 7.56 maximum rising by 0.1mm. these spacer rings are supplied as whole ring .for selection and assembly of spacer ring proceed as follows.</li> <li>• Insert two spacer rings of equal thickness between the two outer races of taper roller bearings. Thickness of the spacer rings should checked using micrometer. Feel frictional moment with hand and select spacer thickness for trial assembly.</li> <li>• Hold the spacer ring of thickness to be tried across V grooved on a table vice and split it in to two pieces by tapping with hammer. Round off the split ends of spacer ring by grinding or remove the burr by filing.</li> </ul>
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		<ul style="list-style-type: none"> <li>• Insert these two pieces of spacer rings between two pieces of taper roller bearings.</li> <li>• Measure the friction moment with the help of gauge and clamp.</li> <li>• If friction moment is found to be either less than 5 cm kg or more than 20 cm kg, thicker or thinner split spacer rings have to be fitted respectively</li> </ul>
6	<p>INSTALLATION OF TAIL PINION ASSEMBLY IN THE HOUSING</p>	<ul style="list-style-type: none"> <li>• Clean the housing thoroughly. Check the threads and bearing bores for damage</li> <li>• Mount the axle beam assembly on the work stand. Adjust position of the axle beam such that tail pinion bearing bore faces upward</li> <li>• Oil cylindrical roller bearing mounting bore and the bearing outer race</li> <li>• Locate the chamfer on the outer race of the cylindrical roller bearing in its mounting bore and tap it in using drift.</li> <li>• Oil tail pinion taper roller bearing mounting bore, threads and also cylindrical roller bearing outer race</li> <li>• Insert the tail pinion depth adjusting shims on its seats in the tail pinion taper roller bearing mounting bore</li> <li>• Clamp down pronged wrench to the coupling flange using 2 M8 X 30 long screws and nuts. With this split spacer ring will be held tight between outer races of tail pinion taper roller bearing. Align the splits spacer ring and tighten M8 screw.</li> <li>• Insert tail pinion assembly with wrench in the mounting bore giving light taps with a mallet till the threaded ring aligns with its threads in the housing. Loosen the 2 M8 nuts</li> <li>• Install torque multiplier (ratio 1:4) over the pronged wrench and tighten to specified torque.</li> <li>• Note: The torque multiplier handle should be firmly held by hooking with holder to the stand to enable the threaded ring to be tightened to this high torque Check the tail pinion depth using gauge as follows:</li> <li>• Mount dial gauge (0.01 least count X 10 mm stroke) in the depth gauge</li> <li>• With the help of the setting piece provided (screwed on the gauge), set the dial gauge to read zero at the same time preload the gauge to read, say 4mm (on the smaller pointer in the dial gauge) The above reading gives a basic setting measured from the center of the differential side bearing bore to the tail pinion spigot face. The actual basic setting value of the gauge is etched on the plunger guiding block</li> </ul>

		<ul style="list-style-type: none"> <li>• The pinion depth required to be adjusted for a particular pair of crown wheel and pinions is etched on the periphery of the crown wheel. For instance, the depth dimension etched is 57.5 mm .Ensure that the set number etched on crown wheel as well as on tail pinion is the same</li> <li>• Clean differential bearing halves in the housing ,spigot face and the centre hole for the tail pinion</li> <li>• Insert tail pinion depth measuring gauge preset to basic setting value. In to the central housing taking precaution to see that the centre pin of tool rests in centre hole of tail pinion and measuring plunger of gauge rests on spigot face of the tail pinion..</li> <li>• If now dial gauge reads zero with smaller pointer at 4mm.it means that the tail pinion depth is same as actual basic setting value of the gauge. I.e. 55.7mm.</li> <li>• for example if the tail pinion depth for this particular set is required to be adjusted to 55.50 mm. all that is required to reduce the thickness of tail pinion depth adjusting shims by 0.20 mm.</li> <li>• Tail pinion shims are available in following 7 thickness 0.05, 0.10, 0.15, 0.20, 0.25, 0.5 and 1.50 mm.</li> <li>• Remove pinion depth adjusting gauge from the housing.</li> <li>• Remove tail pinion assembly from the housing as per procedure out lined earlier removal of tail pinion assembly from the housing.</li> <li>• Measure total thickness of adjusting shims and reduce it by 0.2 mm by selecting of correct thickness of shims.</li> <li>• Reassemble tail pinion assembly in the housing with the shims of selected thickness. .Smear the thread of threaded ring with shellac before assembly and tighten the threaded ring to specified toque. Remove pronged wrench.</li> <li>• Recheck and conform the tail pinion depth to etched value.</li> </ul> <p>Note :</p> <p>To increase or decrease tail pinion depth, increase or decrease thickness of adjusting shims.</p> <p>Maximum permissible variation in the pinion depth from etched value on the crown wheel should be within 0.05mm.</p> <p>When the dial gauge reads to the left of zero it indicates an increase in depth from setting value and vice versa.</p>
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		<ul style="list-style-type: none"> <li>• Stake collar on the coupling nut in the slot provided in tail pinion such that nut is locked against loosening..</li> <li>• Fit the lock plate with tab washer in slot of tail pinion threaded ring and lock it in position.</li> </ul>
7	Dismantling of crown wheel and differential assembly.	<ul style="list-style-type: none"> <li>• With the help of puller and thrust piece extract differential side bearing inner race with roller cage from the differential housing .Turn assembly and remove bearing from the cover side.</li> <li>• Note; the finger of puller must fit into the two slot in differential housing /cover so that the inner race is properly gripped prior to extraction.</li> <li>• Chip off welding and remove the lock plates holding crown wheel and differential carrier mounting bolts.</li> <li>• Unscrew the crown wheel mounting bolts and tap the crown wheel from the differential carrier using mallet. Check mating marks on differential housing and cover half. Unscrew differential cover mounting bolts and separate out cover from the differential housing.</li> <li>• Remove axle shaft gears ,thrust washers, spider ,bevel gears and spherical washers</li> </ul>
8	Inspection of crown wheel and differential components.	<p><u>Crown wheel</u> Teeth for scores, burrs, overheating, marks etc. If any of these defects are observed replace crown wheel and tail pinion in a set.</p> <p>Condition of bolt mounting threads. Ease threads, <u>Differential housing/ cover</u> Differential side bearing mounting diameter for scores, and sign of bearing inner race rotation. Axle shaft gear thrust washer mounting face and bevel gear spherical washer resting surface for scoring /pitting marks.</p> <p><u>Gears</u> Splines on axle shaft gears. Spider for wear. Spherical face on bevel gears for pitting marks. Teeth of shaft gears and bevel gears for scores, burrs etc. If any damage is observed replace the parts.</p> <p><u>Thrust washers and spherical washers</u> Check washers for wear or damage. if necessary replace them in sets, Side bearings Check for sign of pitting, scoring, burrs, overheating etc. Replace bearing if necessary</p>

9	Assembly of differential and crown wheel	<ul style="list-style-type: none"> <li>• Clean parts.</li> <li>• Oil and assemble differential side gear with brass thrust washer in the differential cover. The grooved face of thrust washer must face towards axle shaft gear.</li> <li>• Oil and assemble the spider, bevel gears, spherical washers in differential cover Note: the assembly of differential spider bevel gears and axle shaft gears should rotate freely without binding. End play of axle shaft gear should be 0.025 to 0.10mm. Adjust backlash by selecting brass thrust washers of correct thickness. Thrust washers are available in seven thicknesses from 1.25 to 1.55mm in steps of 0.05mm. using feeler gauge check end play of side gears.</li> <li>• Oil and assemble the differential side gear with washers on the bevel gears.</li> <li>• Align the mating marks and assemble the differential housing on the cover.</li> <li>• Oil threads of differential cover and screw in mounting bolts. Tighten bolts to specified torque.</li> <li>• Support differential assembly on two v blocks and check lateral run out of the crown wheel mating surface on the housing. Maximum permissible face run out 0.03mm.</li> <li>• Oil and press differential side bearing inner race using drift on differential assembly till they flush on the collars.</li> <li>• Locate new lock plates on differential and crown wheel mounting bolts. If necessary, for proper seating of lock plates, adjust bolts heads within 6 to 8 mkg torque by further tightening, if necessary.</li> <li>• Lightly tack weld with an electric arc individual lock plates to the carrier at the hole provided in the lock plate. Clean and blow out slag .ensure that no particles enter differential carrier. Check for proper welding.</li> </ul>
10	Installation of Differential With Crown Wheel In Carrier Housing	<ul style="list-style-type: none"> <li>• Thoroughly clean and oil differential bores/threads in the housing/bearing caps.</li> <li>• Tilt the differential/crown wheel assembly towards right from top and carefully insert the assembly with the appropriate outer races of the taper roller bearings in the carrier housing</li> <li>• Fit the outer races of the side bearing snugly against their respective roller cages. Position</li> </ul>

		<p>differential/crown wheel assembly centrally in the side bearing bores.</p> <ul style="list-style-type: none"> <li>• Clean and oil threads of the threaded rings. Rest them against the bearing outer races and the threading in the housing.</li> <li>• Thoroughly clean the differential side bearing cap specially the mating surfaces. Check condition of dowel pins in the cap and their mating holes in the housing.</li> <li>• Fit bearing caps, aligning the dowel pins and matching the threads in the ring. Lightly tap caps for proper seating.</li> <li>• Clean and oil threads of the bearing cap mounting bolts. Screw in the bolts by hand. If it is hard to screw in bolts, it indicates that the threads in the threaded ring and in the cap have not aligned. Do not attempt to tighten the bolts by force, as it will damage the threads. If any of the bolts is hard to screw in, remove the cap and reposition threaded ring. Reassemble the cap, till the threaded ring can be turned freely with the cap bolts tightened to 3 mkg torque.</li> <li>• Tighten side bearing cap mounting bolts to 12 mkg torque. Loosen them by quarter turn.</li> <li>• With the help of wrench tighten both the threaded rings evenly and equally at the same time revolve the crown wheel assembly. This will be possible if the crown wheel assembly has been correctly centered in the side bearing bores. Check that no lateral play is present between differential assembly and side bearings.</li> <li>• Mount dial gauge with magnetic stand on the housing.</li> <li>• To measure the backlash between crown wheel and tail pinion teeth hold the tail pinion firmly using a lock bolt nut between coupling flange threaded ring and move the crown wheel. The crown wheel assembly should be roughly positioned in the housing such that backlash should read between 0.5 and 1.00 mm.</li> </ul> <p><i>Note: If backlash is less than 0.5 mm loosen the left adjusting ring equally tighten the right one to increase backlash. With this adjustment crown wheel moves away from tail pinion. If backlash is more than 1.0 mm, loosen the right adjusting ring equally tighten the left adjusting ring to decrease backlash. Crown wheel will move towards pinion.</i></p> <ul style="list-style-type: none"> <li>• When this provisional setting of 0.5 to 1.0 mm is achieved, loosen the right threaded ring by about two turns and tighten the left threaded ring till the backlash between the crown wheel and pinion is reduced to 0.15 mm.</li> <li>• Rotate crown wheel and check backlash at four places</li> </ul>
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		<p>90° apart.</p> <ul style="list-style-type: none"> <li>• Tighten left hand side cap mounting bolts to 6 mkg torque.</li> <li>• Tighten right side threaded ring till the backlash 0.20 mm is achieved.</li> <li>• Check crown wheel for free rotation.</li> <li>• Tighten both the differential side bearing cap mounting bolts to 12 mkg torque.</li> <li>• Recheck backlash at four places 90° apart. The mean of these backlashes should be between 0.20 and 0.26 mm. If not, loosen the cap mounting bolts and reset by adjusting threaded rings.</li> <li>• Mount dial gauge with the help of magnetic stand on the housing and check lateral runout of the crown wheel. Maximum permissible lateral runout of crown wheel 0.06 mm.</li> <li>• Mount threaded ring lock plates on the bearing caps. Screw in the bolts along with the tabs washer. Tighten the bolts fully and lock the tab washer.</li> </ul>
11	Crown Wheel/Tail Pinion Tooth Contact Checking	<ul style="list-style-type: none"> <li>• Lightly smear red lead paste in three or four consecutive teeth of the crown wheel.</li> <li>• Turn the tail pinion in normal forward drive direction several times. Load the crown wheel slightly by putting a wooden wedge between the crown wheel periphery and the housing.</li> <li>• Study the contact pattern on drive (convex) and coast (concave) face of the teeth.</li> <li>• <b><i>Note: in practice, it may not be possible to obtain the ideal contact exactly as shown. However, it must be ensured that the contact is not confined to either the root top, toe or heel portion of the crown wheel but is generally around the pitch line of the crown wheel.</i></b></li> </ul>
12	Inspection Of Axle Beam	<ul style="list-style-type: none"> <li>• Hub nut mounting threads for damage ease threads.</li> <li>• Hub bearing seat diameter.</li> <li>• Concentricity of bearing mounting spindle diameters. It should not exceed the limit of 0.03mm</li> <li>• Visually check oil seal pressure ring on beam for groove formation. Replace the pressure ring if groove formation is noticed.</li> <li>• Check oil deflector for correct fitment with the oil hole at the bottom.</li> <li>• Check axle beam for bend. Replace the beam if any of the above defects are observed.</li> </ul>
13	Installation of Anchor Plate On The Axle Beam	<ul style="list-style-type: none"> <li>• Mount anchor plate assembly on the axle beam flange and fasten it with bolts, nuts and spring lock washers.</li> <li>• Tighten anchor plate mounting nuts to 12 mkg torque.</li> </ul>

14	Dismantling of Hub Assembly	<ol style="list-style-type: none"> <li>1. Using support and puller extract. <ol style="list-style-type: none"> <li>a. Hub inner bearing assembly with the grease seal and spacer ring.</li> <li>b. Hub outer bearing assembly with outer oil seal and spacer ring.</li> </ol> </li> </ol> <p><i>Note: Ensure that rocker rests on the bearing outer race through two cut-outs given in their resting collars.</i></p> <ol style="list-style-type: none"> <li>2. Paint identification marks on inner/outer races of the respective LH and RH hub taper roller bearings.</li> <li>3. Clean all the parts thoroughly.</li> </ol>
15	Inspection Of Brake Drum & Hub Components	<ol style="list-style-type: none"> <li>1. A Brake Drum <ol style="list-style-type: none"> <li>a. Check for cracks</li> <li>b. If deep scoring is observed on the friction surface rectify by skimming the friction surface.</li> <li>c. If necessary, replace assembly.</li> </ol> </li> <li>2. Hubs <ol style="list-style-type: none"> <li>a. For cracks</li> <li>b. Axle shaft mounting studs for condition of threads</li> <li>c. Bearing seats for wear, pitting, etc.</li> <li>d. Concentricity between bearing mounting bores and ovality of the bores.</li> </ol> </li> <li>3. Hub bearing for signs of scoring, pitting, overheating, etc.</li> <li>4. Inner and outer seals for lip wear.</li> <li>5. Wheel mounting pins for fit in hub and condition of threads.</li> </ol> <p><i>If any of the above defect is observed replace the defective parts.</i></p>
16	Assembly Of Hub	<ul style="list-style-type: none"> <li>• Clean hub thoroughly and oil bearing seat surfaces in the hub.</li> <li>• Using drift press outer race of the inner bearing.</li> <li>• With drift press outer race of the outer bearing till it rest on the collar in the hub.</li> </ul> <p><i>Note: If bearings are being reused ensure that their races are not interchanged.</i></p> <ul style="list-style-type: none"> <li>• Position the inner race with cage of inner bearing in the hub.</li> </ul>
17	Installation Of Hub Assembly	<p><b>Selection of Shims</b></p> <ul style="list-style-type: none"> <li>• Thoroughly clean the bearing seats on the rear axle tube.</li> <li>• Insert hub assembly without inner race of outer taper roller bearing on the axle tube.</li> <li>• Assemble the tubular spacer on the axle tube.</li> <li>• Insert a shim of 2.50 mm thick on the tubular spacer.</li> <li>• Insert inner race of outer bearing on axle tube.</li> <li>• Rest drift on the inner race of the outer bearing and tap it with mallet till it gets located on the spindle.</li> <li>• Mount tongued spacer on the axle tube and screw in</li> </ul>

		<p>the inner slotted nut with the help of wrench. Tighten the nut to approximately 10 mkg torque.</p> <ul style="list-style-type: none"> <li>• Slide inner race of outer bearing on rear axle tube.</li> <li>• Hammer the hub front face gently, so that the wheel bearings seat and run freely.</li> <li>• Mount dial gauge on magnetic stand. Rest dial plunger on the outer face of the axle spindle. Measure the hub play.</li> </ul> <p><b>For example, the measured hub play is 1.5 mm. Then correct shim size for hub play of 0.06 mm will be <math>(2.50 - 1.50 + 0.06) = 1.06</math> mm. The recommended hub play is between 0.04 to 0.1 mm. To achieve this hub play shim may be added or removed. For increasing the play, shims to be added and for decreasing the play, shims to be removed.</b></p> <ul style="list-style-type: none"> <li>• Loosen and remove slotted nut and pull out the hub with bearings.</li> <li>• Thoroughly clean bearing seats on the axle tube and oil them.</li> <li>• Pack roller cage of the inner bearing with grease and refit it properly in its outer race.</li> <li>• With drift install inner grease seal with its spacer ring.</li> <li>• Pack each hub with approximately 300 gms of recommended grease.</li> <li>• Insert hub assembly on the axle beam spindle, carefully taking care that the grease seals are not damaged.</li> <li>• Pack roller cage of the outer bearing with grease and rest it properly in its outer race.</li> <li>• Locate tubular spacer along with preselected shims (as mentioned in step 10) and inner race of outer bearing on the axle tube.</li> <li>• Rest drift on the inner race of the outer bearing and tap it with mallet till it gets located on the spindle.</li> <li>• Mount tongued spacer on the axle tube.</li> <li>• Using drift install outer oil seal.</li> <li>• Screw in the inner slotted nut with the help of wrench. Tighten the nut to 20 mkg torque.</li> <li>• Insert a new lock washer to rest over the inner slotted nut.</li> <li>• Screw in slotted check nut with the help of wrench. Tighten the check nut to 20 mkg torque. If in this position none of the slot of check nut line up with lip of lock washer, loosen check nut just enough to align a slot with lip of lock washer.</li> <li>• Hammer the hub front face gently, so that the wheel bearing seat and run freely.</li> <li>• Mount dial gauge on magnetic stand. Rest dial plunger on the outer face of the axle spindle.</li> <li>• Measure the hub play. Now the play should be</li> </ul>
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		<p>between 0.04 to 0.01 mm. If not, readjust the hub play on this value.</p> <ul style="list-style-type: none"> <li>• Remove dial gauge with stand.</li> <li>• Bend the lip of the lock washer in the slot of slotted nut and lock it.</li> </ul>
18	Inspection Of Axle Shaft	<p><b>Check the following</b></p> <ul style="list-style-type: none"> <li>• Axle shaft for bend.</li> <li>• Splines for damage.</li> <li>• Cracks.</li> <li>• Axle shaft flange holes.</li> <li>• <i>If any of the above defects is observed, replace the axle shaft.</i></li> </ul>
19	Assembly Of Axle Shaft	<ul style="list-style-type: none"> <li>• Fix new gasket on hub.</li> <li>• Insert axle shaft in the axle beam taking care not to damage the oil deflector provided in the beam.</li> <li>• Tap the axle shaft with mallet till it engages fully on the studs provided in the hub.</li> <li>• Tighten axle shaft mounting nut to specified torque.</li> </ul>
20	Removal Of Propeller Shafts From Vehicle	<ul style="list-style-type: none"> <li>• Unlock and unscrew coupling flange fastening screw/nuts to disconnect rear propeller shaft from rear axle. Carefully place rear end of rear propeller shaft on ground.</li> <li>• Unscrew and loosen hose clips from both ends of sliding joint rubber boot. Carefully pullout and remove rear propeller shaft.</li> <li>• Unscrew nuts to remove center bearing bracket from cross member. Carefully place rear end of front propeller shaft on ground.</li> <li>• Unlock and unscrew coupling flange fastening screw to disconnect front propeller shaft from gearbox. Remove front propeller shaft.</li> </ul>
21	Installation Of Propeller Shaft On Vehicle	<ul style="list-style-type: none"> <li>• Assemble in such a way that all the yokes of propeller shafts are in one plane.</li> <li>• Use new lock plates for coupling flange fastening screw/nuts.</li> <li>• Tighten coupling flange screws/nuts to specified torque and lock them with lock plate.</li> <li>• Tighten center bearing bracket fastening screw/nuts.</li> </ul>
22	Removal of center bearing from front propeller shaft	<p><b>Center bearing mounting arrangement</b></p> <ul style="list-style-type: none"> <li>• Slide off center bearing bracket from front propeller shaft by tapping with a mallet.</li> <li>• Slide off rubber bush from center bearing.</li> <li>• Remove spacer ring gear.</li> <li>• With puller pullout center bearing assembly from front propeller shaft.</li> <li>• Remove front spacer ring.</li> </ul>

23	Inspection of center bearing	<ol style="list-style-type: none"> <li>1. Clean all components thoroughly.</li> <li>2. Check condition of splines and threads on front propeller shaft.</li> <li>3. Check condition of bore and mounting holes of center bearing bracket.</li> <li>4. Check condition of rubber bush. Replace with new one if necessary.</li> </ol> <p><i>Note: Rubber bush is made of nitrile rubber which is resistant to grease, oil and heat. Replace it only with genuine part.</i></p> <ol style="list-style-type: none"> <li>5. Check center bearing assembly for. <ol style="list-style-type: none"> <li>a. Condition of both rubber seal.</li> <li>b. For checking of center bearing proceed as follows <ul style="list-style-type: none"> <li>• Clean center bearing assembly with diesel only.</li> <li>• Do not use kerosene or petrol for cleaning.</li> <li>• For judging silent running of bearing, apply few drops, of engine oil to cleaned bearing and rotate it. There should be no binding.</li> <li>• The bearing should have negligible radial play.</li> </ul> </li> </ol> </li> </ol> <p><i>Note: If any above is defective complete center bearing assembly should be replaced.</i></p> <ul style="list-style-type: none"> <li>• Check both spacer rings for wear/score marks. If found defective replace with new one.</li> </ul>
24	Installation Of Center Bearing On Front Propeller Shaft	<ul style="list-style-type: none"> <li>• Install one center bearing spacer ring in such a manner on front propeller shaft rear end that its chamfered surface with notches comes in contact with inner race of center bearing.</li> <li>• Install center bearing assembly on front propeller shaft rear end.</li> <li>• Install other spacer ring for center bearing on front propeller shaft rear end, in such a manner that its chamfered surface with notches will come in contact with inner race of center bearing.</li> <li>• Apply glycerin on periphery of center bearing rubber bush.</li> <li>• Install center bearing in bracket using drift.</li> </ul>
25	Disassembly of Universal joint	<ul style="list-style-type: none"> <li>• Clean paint and dust from circlip and top of bearing cups.</li> <li>• Remove all circlip by pressing with a circlip plier. If necessary, tap bearing cups lightly with mallet.</li> <li>• Rest yoke on suitable support and press bearing cup using suitable spacer on a hand press.</li> <li>• Hold the projected portion of bearing cup in a vise and tap fork with mallet to remove bearing cup.</li> <li>• Rest opposite side of yoke on support and press other bearing cup using suitable spacer to the max position till cross just touches the fork.</li> <li>• Hold the projected portion of bearing cup in a vise and tap fork with mallet to remove bearing cup.</li> </ul>

		<ul style="list-style-type: none"> <li>• With same procedure, press out the remaining two bearing cups.</li> <li>• <b>Note: Disassembly universal joint, bearing cups, rod, needle and cross should be replaced.</b></li> </ul>
26	Inspection Of Universal Joint	<ul style="list-style-type: none"> <li>• Clean all metal parts thoroughly in a cleaning solvent, but wipe rubber parts only with a dry cloth.</li> <li>• Measures the diameter of bearing cup mounting bores in propeller shaft yokes.</li> <li>• Measure inner bores of bearing cups. Check for wear, damage overtightening, etc.</li> <li>• Measure outer diameter of bearing cups and check for required fit in corresponding mounting bores in propeller shaft yokes. Both should have same color code mark for correct fit.</li> <li>• Check needle rollers for pitting, damage, wear, overheating, etc.</li> </ul> <p><b>Note: All needle roller in four bearing cups of a cross assembly should be from same set.</b></p> <ul style="list-style-type: none"> <li>• Check cross for damage, wear, overheating, etc. Measure diameters of cross spigots.</li> <li>• Check rubber seal and sheet metal retainer for damage. Replace these, if necessary.</li> <li>• Check lubrication passage in cross.</li> <li>• <b>Note: If any of the above defect is observed replace complete cross assembly.</b></li> </ul>
27	Assembly Of Universal Joint	<ul style="list-style-type: none"> <li>• Clean needle rollers and bearing cups thoroughly.</li> <li>• Smear grease on the needle rollers and bearing cups.</li> <li>• Assemble needle rollers in the bearing cups.</li> </ul> <p><b>Note: Ensure that each cup is assembled with 28 needle rollers. All four bearing cups of an universal joint should have same color code mark and should be assembled with needle rollers from same set.</b></p> <ul style="list-style-type: none"> <li>• Fit seals on cross and press in seal cup. Stake the seal cup in the groove provided on the body of the bearing cup.</li> <li>• Fit grease nipple on the cross and install the cross in the propeller shaft yokes.</li> </ul> <p><b>Note: Grease nipple on the cross should face propeller shaft and not coupling flange.</b></p> <ul style="list-style-type: none"> <li>• Press the needle roller bearing cup assembly in the yokes using suitable spacer on a hand press. Ensure that color code on yoke and bearing cup are same for correct fit.</li> <li>• After pressing in the bearing cups, secure them in position with circlip in selection.</li> <li>• The universal joint should be assembled with 0.02 to 0.04 mm axial play. After assembly, slightly tap the yokes with a mallet to ensure proper assembly.</li> <li>• Grease the universal joint.</li> </ul>

28	Inspection Of Rear Propeller Shaft	<p><b>Rear propeller shaft</b></p> <ul style="list-style-type: none"> <li>• Unscrew and loosen hose clips from both ends of rubber boot.</li> <li>• Slide off yoke from shaft.</li> <li>• Remove rubber boot and check its condition.</li> <li>• Clean and apply grease to splines on shaft and yoke.</li> <li>• Install rubber boot on splined shaft.</li> <li>• Slide yoke onto shaft ensuring alignment of mating arrows.</li> <li>• Check for free sliding of yoke on shaft.</li> <li>• Tighten hose clip at both ends of rubber boot such that screws on hose clip strap are diametrically opposite to each other.</li> <li>• Check rear propeller shaft for bend by suitably clamping coupling flanges at both ends. If necessary straighten.</li> </ul> <p><i>Note: All straightening operation are to be done with complete shaft assembly.</i></p> <ul style="list-style-type: none"> <li>• Check rear propeller shaft for dynamic imbalance.</li> <li>• Pack grease in sliding joint with grease gun through grease nipple.</li> <li>• <b>Caution: Avoid over greasing. Since this may burst the rubber boot</b></li> </ul>
29	Inspection of Front Propeller Shaft	<ul style="list-style-type: none"> <li>• Remove coupling flange and center bearing with bracket from front propeller shaft.</li> <li>• Check front propeller shaft for bend. If necessary straighten.</li> <li>• Check front propeller shaft by dynamic imbalance.</li> <li>• Install center bearing with bracket and coupling flange on front propeller shaft.</li> </ul>

## E. Repair Transaxle

S.N	Assignment	Skill
1.	Transaxle Disassembly	<ol style="list-style-type: none"> <li>1. Ensure that the oil is drained completely from transaxle before mounting on the work stand.</li> <li>2. Fix mounting plate on work stand by using hex bolt on mounting plate.</li> <li>3. Mount transaxle face on mounting plate and fix it by hex bolts and remove assembly reverse light switch.</li> <li>4. Turn the table by 90 degree.</li> <li>5. Lock input shaft by adaptor.</li> <li>6. Turn back the table by 90 degree.</li> <li>7. Remove assembly rear cover.</li> <li>8. Remove the spiral pin of shifter fork (5<sup>th</sup> speed).</li> <li>9. Unscrew the locknut on lay shaft.</li> <li>10. Unlock and remove lock nut on input shaft.</li> <li>11. Engage any of the gears for locking the lay shaft.</li> <li>12. Remove lock plate( 5<sup>th</sup> speed gear)</li> <li>13. Remove 5<sup>th</sup> gear shifter sleeve from lay shaft along with 5<sup>th</sup> speed shifter fork.</li> <li>14. Remove engaging gear 5<sup>th</sup> speed along with 5<sup>th</sup> gear and synchrocone ,taking care carrier assembly does not slip off.</li> <li>15. Remove needle bearing.</li> <li>16. Remove bush.</li> <li>17. Remove spacer (lay shaft)</li> <li>18. Remove conical washer and 5<sup>th</sup>gear (input shaft).</li> <li>19. Remove lock plate (lay shaft bearing) from housing rear half by unscrewing T40 torx head screws.</li> <li>20. Remove lock plate input shaft bearing from housing (rear half) by unscrewing the screws.</li> <li>21. Remove hex bolts on detent plate and remove gasket, detent plate springs and steel balls.</li> <li>22. Take note of sequence of springs1 R/5 spring hard,two springs soft for 1/2 and 3/4.</li> <li>23. Remove hex flange bolts .Remove bracket for retaining clutch spring on rear half housing.</li> <li>24. Remove reverse idler shaft and reverse idler gear.</li> <li>25. Remove double dowel pins of shifter fork(1<sup>st</sup> and 2<sup>nd</sup>).</li> <li>26. Remove spiral pin of shifter dog (Rev).</li> </ol>

		<ol style="list-style-type: none"> <li>27. Remove spiral pin of shifter dog (3<sup>rd</sup> and 4<sup>th</sup> )</li> <li>28. Remove spiral pin of shifter dog (1<sup>st</sup> and 2<sup>nd</sup> )</li> <li>29. Remove shifter shaft (3<sup>rd</sup> and 4<sup>th</sup>), shifter shaft (5<sup>th</sup> and reverse) and shifter shaft (1<sup>st</sup> and 2<sup>nd</sup>).</li> <li>30. Remove shifter fork (3<sup>rd</sup> and 4<sup>th</sup>) and also lock plate on shifter selection bracket (for 4<sup>th</sup> speed gear ).</li> <li>31. Please do not try to remove shifter fork (1<sup>st</sup> and 2<sup>nd</sup>)</li> <li>32. Remove selection shifter bracket assembly by removing mounting screws.</li> <li>33. Now remove shifter fork (1<sup>st</sup> and 2<sup>nd</sup>).</li> <li>34. Remove inter lock pieces.</li> <li>35. Remove adaptor plate for locking input shaft .tap input shaft assembly gently from spline end .simultaneously also pry out the lay shaft assembly gently so that both lay shaft assembly come out of intermediate plate simultaneously.</li> <li>36. Remove intermediate plate mounting screws.</li> <li>37. Remove the stopper bracket (Reverse idler)</li> <li>38. Pry out gently the intermediate plate from housing (front half).</li> <li>39. Unlock the lock nut and unscrew and remove the locking screw on lever (selection /shifting).</li> <li>40. Remove the differential assembly from the housing front.</li> <li>41. Pull out assembly shaft (selector /shifting) from lever (selection /shifting) and below holder with oil seal from housing front half.</li> <li>42. Pry out oil seal of shaft (selector /shifting) from bellow holder and replace it with new one. While assembling do not use the old oil seal.</li> <li>43. Remove rubber bellow and replace if it is damaged.</li> <li>44. Remove assembly hex screw(speedo lock plate) along with lock plate (speedo gear )</li> <li>45. Remove speedo adaptor with speedo pinion and oil ring.</li> <li>46. Replace oil seal (speedo shaft) if damaged.</li> <li>47. Replace O ring if damaged.</li> <li>48. Remove input shaft cover by removing mounting screws.</li> <li>49. Pry out oil seal from the cover. (if damaged) and replace it with new one.</li> <li>50. Remove hex flanged screw holding release lever on to</li> </ol>
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		<p>release yoke and take out release lever from release yoke.</p> <p>51. Remove plastic bushes at both ends of clutch release fork and remove clutch release shaft from inside.</p> <p>52. Remove oil seal of drive shaft from both housing (front and rear half) Replace it with new one while assembling.</p> <p>53. Remove bearing outer races of differential side bearing along with shims. Ensure that outer races are not interchanged.</p> <p>NOTE:</p> <ul style="list-style-type: none"> <li>• Apply Anabond112 on threads of all fasteners.</li> <li>• Apply RTV silicon liquid gasket anabond 676 on housing interface.</li> <li>• The chips collected by magnetic drain plug are to be removed at time of every oil change.</li> <li>• Keep inner races and outer races of taper roller bearings in sets.</li> <li>• Use sealing anaerobic compound for oil seals outer diameter.</li> <li>• For oil seals of input driveshaft and bellows use anabond 112.</li> <li>• Fit clutch release fork shaft. Fit plastic bushes. Fit lever on clutch release shaft and locked it by grooved pin.</li> <li>• Fix delrin bush and rubber bush in to assembly shaft (selector /shifter). Ensure that delrin bush is at the centre of the hole of the selector/shifter shaft boss.</li> <li>• Fit rubber below on assembly shaft (selector /shifter shaft)</li> <li>• Fit new oil seal in new bellow holder (if damaged) press pt of assembly shaft in to housing front half.</li> <li>• Assemble shaft through oil seal and fix the lever (selector /shifting) by lock nut and lock screw. Ensure that the locking screw gets locked in shaft (selector /shifter) center hole.</li> </ul>
2	Differential bearing preload adjustment procedure.	(a) Measure dimension A(distance between top mating

		<p>surface trans axle front half and outer differential bearing seat) say 103.7mm in housing and dimension B (distance between mating surface of transaxle rear half and inner differential bearing seat) say 19mm in housing for bore 65.088mm dia.</p> <p>(b) Place outer race in both differential side bearings and measure distance between outer surfaces of outer races (dimension C)</p> <p>(c) Select shim thickness = <math>(A+B)-C</math> to <math>(A+B)-C +0.05</math> And install the shim against front half taper roller bearing outer race.</p> <ol style="list-style-type: none"> <li>1. Fix outer race of differential side bearing in the housing (front half) by using drift.</li> <li>2. Fix oil seal in housing front half using drift.</li> <li>3. Place assembly differential in front half housing .Ensure that the dowel sleeve should be there on front half before the intermediate plate assembly.</li> <li>4. Assemble intermediate plate along with stopper plate (reverse idler gear by means of mounting bolts).Tighten the bolts to specified torque.</li> </ol> <p><b>Caution</b> Bolts near the idler shaft hole of stopper plate are shorter.</p> <ol style="list-style-type: none"> <li>5. Place lay shaft assembly and input shaft assembly together (front half).Tap lay shaft and input shaft gently and simultaneously. Do not press fully (till there is gap of around 2mm between lower face of first gear lay shaft and intermediate plate mounting bolt head)</li> <li>6. Place inter lock pieces.</li> </ol> <p><b>Caution</b></p> <ul style="list-style-type: none"> <li>• Ensure that the lug positions while assembling the intermediate plate.</li> <li>• Ensure that the shifter fork is assembled with ribbed face upwards on shifter sleeve ½.</li> </ul> <ol style="list-style-type: none"> <li>7. Fix subassembly bracket (selection /shifting) by mounting screws.</li> <li>8. Place shifter fork 3rd/4th on shifter sleeve ¾ by keeping ribbed face upward.</li> <li>9. Place shifter shaft 1/2 in to shifter fork hole, and lock</li> </ol>
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		<p>it by spiral pin.</p> <p><b>Caution</b></p> <ul style="list-style-type: none"> <li>• While placing all three shifter shafts ensure that three notches on it are upwards and facing the bracket and the shafts are located properly in the inter lock pieces.</li> </ul> <ol style="list-style-type: none"> <li>10. Assemble shifter dog (1/2) on shifter shaft by keeping its dog slot downward and lock it on shifter shaft by spiral pin.</li> <li>11. Assemble shifter shaft 3/4 through shifter fork and shifter dog below its dog slot and lock it with shifter fork and shifter dog by spiral pins.</li> <li>12. Locate the reverse shifter dog slot in to pin on bkt and place shifter shaft 5/R, locate and lock shifter dog on shifter shaft with spiral pin.</li> <li>13. Assemble reverse idler shaft with assembly reverse idler gear, and new spring and spacer.</li> </ol> <p><b>Caution</b></p> <ul style="list-style-type: none"> <li>• The slot in reverse idler shaft is to be located in groove in front gear box housing.</li> <li>• Fix the lever (on assembly bracket) in to the slot of reverse idler gear.</li> <li>• Ensure that all the spiral pins are pressed properly .assemble the housing (rear half) on lay shaft ,input shaft and shifter shaft and tap it gently and uniformly so that it gets located on lay shaft and input shaft bearing.</li> </ul> <p><b>Note</b></p> <ul style="list-style-type: none"> <li>• Care to be taken to locate three shifter shafts in the housing rear half.</li> <li>• Apply liquid gasket on front half /interface.</li> <li>• Fix housing (rear half) and tighten the flanged mounting bolts to specified torque.</li> <li>• Place lock plates of lay shaft bearing and input shaft bearing and fix them by allen screws. Tap the shaft in either direction if required.</li> <li>• Place spacer in lay shaft.</li> <li>• Put input shaft 5<sup>th</sup> gear on lay shaft.</li> </ul> <p><b>Caution:</b></p> <ul style="list-style-type: none"> <li>• Ensure ground face (5<sup>th</sup> gear Input shaft) towards the bearing face.</li> <li>• Put conical washer and lock nut on input shaft.</li> <li>• Place 5<sup>th</sup> gear assembly (lay shaft) with bush and</li> </ul> <ol style="list-style-type: none"> <li>14. Put conical washer and lock nut on input shaft.</li> </ol>
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		<ol style="list-style-type: none"> <li>15. Place 5th gear assembly (lay shaft) with bush and needle cage and synchro pack (5th/R) along with shifter fork (5th gear )on shifter sleeve .Locate shifter shaft hole on shifter fork to shifter shaft.</li> <li>16. Lock the shifter fork on shifter shaft by spiral pin.</li> <li>17. Place lock plate on lay shaft 5th gear assembly.</li> <li>18. Fix lock nut on lay shaft</li> <li>19. Put 3 steel balls and 3 springs in detent holes and gasket (detent plate) and fix detent plate. take care that the blue color spring is for 5/R</li> <li>20. Locate the input shaft from below. Engage any one of the gears.</li> <li>21. Tighten the locknuts on both lay shaft and input shaft to specified torque.</li> <li>22. Stake the collar of both lock nuts on lay shaft and input shaft.</li> <li>23. Check the correct position of shifter shaft by moving the gear shifter shaft assembly in neutral.</li> <li>24. Assemble speedo pinion with speedo adaptor .Fix assembly speedo pinion. Fix assembly hex screw (speedo lock plate) along with lock plate (speedo gear)</li> <li>25. Place assembly rear cover with rubber seal on housing (rear half) and fix it by assembly hex screws.</li> </ol> <p><b>Caution:</b></p> <ul style="list-style-type: none"> <li>• Ensure that tabular portion of rubber seal is seated properly (without any pinching on to the channel in the rear cover)</li> <li>• Tighten the screws to specified torque.</li> <li>• Caution use proper gasket and sealant, clean the rear half and front half inter faces so that no cured and dried liquid gasket remained are left on the machine surface.</li> </ul> <ol style="list-style-type: none"> <li>26. Unlock the input shaft from the below <ul style="list-style-type: none"> <li>• Fix reverse light switch on housing (rear half) magnetic drain plug and filler plug with new washers.</li> <li>• Fix C mount bracket on gear box front housing.</li> <li>• Fix B mount bracket in correct orientation.</li> <li>• Unscrew 3 mounting bolts and dismount the transaxle assembly from adaptor plate on work stand.</li> </ul> </li> </ol>
3	Dismantling of Lay Shaft	<ul style="list-style-type: none"> <li>• Remove ball bearing from lay shaft using holder with puller.</li> </ul>

		<ul style="list-style-type: none"> <li>• Remove spacer.</li> <li>• Remove sub assembly 4<sup>th</sup> gear (lay shaft)'</li> <li>• Remove synchro pack assembly (3/4 speed) carefully so that springs carriers and balls do not jump out.</li> <li>• <u>Synchro pack</u> – shifter sleeve, engaging gear, synchro cone, spring ball carrier (sleeve in case of 1<sup>st</sup> speed gear);</li> <li>• Pry out circlip from layshaft.</li> <li>• Remove 3<sup>rd</sup> gear layshaft.</li> <li>• Pry out circlip from lay shaft.</li> <li>• Remove 2<sup>nd</sup> gear layshaft.</li> <li>• Pry out circlip from lay shaft.</li> <li>• Remove 1<sup>st</sup> gear layshaft.</li> <li>• Pry out circlip from lay shaft.</li> <li>• Place lay shaft upside down and remove cylindrical roller bearing using drift.</li> <li>• Lay shaft assembly</li> </ul>
4	Assembly of Lay Shaft	<ul style="list-style-type: none"> <li>• Press cylindrical roller bearing on lay shaft using drift.</li> <li>• Fit circlip. It should snugly fit.</li> <li>• <b>Note:</b> Circlips are available in different thickness 2.25mm, 2.3mm, 2.35mm, 2.4mm</li> <li>• Place first gear on lay shaft by keeping dog teeth upward.</li> <li>• Place synchrocone (1/2 speed)</li> <li>• Install preselected circlip. Circlips thickness should be so selected that there is no axial play of gear.</li> <li>• Place engaging gear (1/2speed) with circlip races downward and with slot on engaging gear on corresponding lug on synchrocone.</li> <li>• Place springs (3 nos) plungers (3nos) in to the hole in engaging gear.</li> <li>• Place sleeve carrier and steel ball on it and slide reverse gear shifter sleeve (1/2 speed) on it with fork slot in upward position.</li> <li>• Place synchro cone (1/2 speed) and locate its lugs in to the slot of engaging gear.</li> <li>• Place 2nd gear with its dog teeth down ward.</li> <li>• Install pre selected thickness circlip on it.</li> <li>• Place 3rd gear lay shaft with its dog teeth upwards. Fit preselected circlip. There should not be any axial play of gear.</li> <li>• Place synchrocone (3rd gear).</li> <li>• Place engaging gear with circlip recess downward and</li> </ul>

		<p>with slot on engaging gear on corresponding lug on synchrocone. Place springs (3nos) and slide shifter sleeve (3/4/5 speed) on it. Ensure that the slot for fork pad on shifter sleeve (3/4/5) will be in downward position.</p> <ul style="list-style-type: none"> <li>• Place synchrocone (4th gear) and locate its lug in to slots of engaging gear.</li> <li>• Place 4th gear.</li> <li>• Place spacer.</li> <li>• Place ball bearing with taper groove for lock plate side upwards on lay shaft using drift.</li> <li>• Press the cap on lay shaft oil hole bore (below the final drive pinion.)</li> </ul>
5	Input shaft sub assembly Disassembly	<ul style="list-style-type: none"> <li>• Remove ball bearing (rear) by using holder with puller.</li> <li>• Remove ball bearing (front) by using puller.</li> </ul>
6	Input shaft sub assembly Assembly	<ul style="list-style-type: none"> <li>• Press and fit ball bearing (rear) on input shaft using drift with taper groove for lock plate in upward direction.</li> <li>• Place input shaft upside down and press ball bearing (front) by drift.</li> </ul>
7	Dismantling of Differential	<ul style="list-style-type: none"> <li>• Remove taper roller bearing by using puller and rest pad.</li> <li>• Remove speedo gear by using puller and rest pad'</li> <li>• Remove two (1.5 thick) circlips locking the spider.</li> <li>• Caution: do not reuse the 1.5 thick circlips.</li> <li>• Push out spider from differential housing.</li> <li>• Rotate bevel pinions by 90 deg and remove bevel pinions.</li> <li>• Push out spider from differential housing</li> <li>• Rotate bevel pinions by 90deg and remove the side bevel gears.</li> <li>• Remove bevel pinion with washers.</li> <li>• Hold fixture for gear on differential assembly in soft jaw vice.</li> <li>• Mount differential housing on fixture and lock it.</li> <li>• Unscrew and remove the collared bolts</li> </ul>
8	Assembly of Differential	<ul style="list-style-type: none"> <li>• Hold fixture for gear on differential casing on soft jaw vice.</li> <li>• Mount differential housing on fixture and lock it.</li> <li>• Place gear final drive on differential housing .tighten the collared bolts to specified torque.</li> </ul>

		<ul style="list-style-type: none"> <li>• Place bevel pinion on differential housing spherical radius.</li> <li>• Place bevel pinion in similar manner as explained above.</li> <li>• Place both side bevel gears with washer exactly opposite to each other. And rotate by 90 deg so as align the holes on side bevel gears with holes in the housing.</li> <li>• Push the spider in to the holes.</li> <li>• Check the free play of differential gears. it should 0-0.1mm</li> <li>• If the value of play is not within specification add or remove washers.</li> <li>• Assemble the two circlip in to the groove near the ends of spider.</li> <li>• Fix speedo gears with recess inside using drift.</li> <li>• Press taper roller bearing using drift on either side of differential.</li> </ul>
9	Identification of Parts	<p><b><u>Engaging gears</u></b></p> <ul style="list-style-type: none"> <li>• 5<sup>th</sup> engaging gear is having smaller dia inner spline for fitment on lay shaft.</li> <li>• 3<sup>rd</sup> and 4<sup>th</sup> engaging gear is similar in size with 5<sup>th</sup> engaging gear but having bigger inner splines to fit on lay shaft.</li> <li>• 1<sup>st</sup> and 2<sup>nd</sup> engaging gear is having inner splines dia similar to 3<sup>rd</sup>/4<sup>th</sup> engaging gear but outer diameter is bigger to engage with 1<sup>st</sup> /2<sup>nd</sup> shifter sleeve.</li> </ul> <p><b><u>Shifter forks</u></b></p> <ul style="list-style-type: none"> <li>• 5<sup>th</sup> gear shifter fork has three prominent ribs and dowel hole is approx in centre of boss.</li> <li>• 1<sup>st</sup>/2<sup>nd</sup> gear shifter fork has smaller two ribs and locating holes is at extreme corner of the boss.</li> <li>• 3<sup>rd</sup>/4<sup>th</sup> gear shifter fork has a prominent rib and has extended guide for locating the shaft.</li> </ul> <p><b><u>Shifter shafts</u></b></p> <ul style="list-style-type: none"> <li>• 1<sup>st</sup>/2<sup>nd</sup> shifter shaft is the smallest of all with one notch for inter lock piece</li> <li>• 3<sup>rd</sup>/ 4<sup>th</sup> shifter shaft is intermediate in length with two notches at the bottom for two inter lock pieces.</li> <li>• 5<sup>th</sup>/Rev shifter shaft is the longest of all.</li> </ul> <p><b><u>Shifter sleeve.</u></b></p> <ul style="list-style-type: none"> <li>• 5<sup>th</sup>/3<sup>rd</sup>/4<sup>th</sup> shifter sleeve are identical and are interchangeable.</li> <li>• 1<sup>st</sup>/2<sup>nd</sup> shifter sleeve is in integral with reverse gear.</li> </ul> <p><b><u>Synchromone;</u></b></p> <ul style="list-style-type: none"> <li>• 5<sup>th</sup>/4<sup>th</sup>/3<sup>rd</sup>synchromones are having smaller inner dais</li> </ul>

		<p>and are identical</p> <ul style="list-style-type: none"> <li>• 1<sup>st</sup> /2<sup>nd</sup> synchro cones are having bigger inner dais and are interchangeable.</li> </ul> <p><b>Sub assembly</b></p> <p><b><u>5<sup>th</sup> synchro pack assembly</u></b></p> <ul style="list-style-type: none"> <li>• Place needle roller bearing and bush in 5<sup>th</sup> gear.</li> <li>• Assemble the carrier 3/4/5 springs, balls engaging gear and shifter sleeve.</li> </ul> <p><b>Note:</b></p> <ul style="list-style-type: none"> <li>• Engaging gear can be put in either way</li> <li>• Place synchro cone on 5<sup>th</sup> gear lay shaft.</li> <li>• Place synchro pack assembly with shifter sleeve on 5<sup>th</sup> gear .Ensure that slot or fork pad on shifter sleeve 3/4/5 be in downward position.</li> </ul> <p><b><u>3<sup>rd</sup> /4<sup>th</sup> synchro pack assembly</u></b></p> <ul style="list-style-type: none"> <li>• Place the engaging gear such that the groove for circlip is down wards.</li> <li>• Place shifter sleeve on engaging gear 3<sup>rd</sup>/4<sup>th</sup> such that smaller groove is upwards and assemble carriers, springs, and balls</li> </ul> <p><b><u>1<sup>st</sup> /2<sup>nd</sup> synchro pack assembly</u></b></p> <ul style="list-style-type: none"> <li>• <u>Place engaging gear 1<sup>st</sup>/2<sup>nd</sup> such that the groove on circlip is downwards.</u></li> <li>• <u>Place shifter sleeve such that the fork slot is in upward position and assemble the carriers, springs, balls and sleeve.</u></li> </ul>
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## F. Repair Wheels and Tyre System

S. N.	Assignments	Skills
1.	Rotate tyre	
2.	Change tubeless tyre	
3.	Repair Flat tyre	
4.	Repair tubeless tyre puncture	
5.	Change Wheel Rim	
6.	Change Stabilizer bar and Bush	
7.	Maintain tyre pressure	
8.	Change Torsion Bar	
9.	Diagnose Air Suspension System	

**Automotive Engine**  
(16 Weeks – 640 hours)

**A. Repair Cooling System**

S. N.	Assignments	Skills
1.	Check/ Replace Seal/Hoses pipes	<ul style="list-style-type: none"> <li>- Determine the location/ points of leaks.</li> <li>- Drain cooling system.</li> <li>- Clean gasket mating surfaces.</li> <li>- Install new gasket.</li> <li>- Use sealing compound if necessary.</li> <li>- Inspect hose and clamp.</li> <li>- Replace hoses and clamp if needed.</li> <li>- Tighten attaching bolts.</li> <li>- Refill cooling system to proper level with coolant.</li> <li>- Test pressure system for leaks.</li> <li>- Operate engine until it reaches normal operating temperature.</li> <li>- Recheck coolant level.</li> </ul>
2.	Change Radiator, radiator fan and Motor	<ul style="list-style-type: none"> <li>- Consult service manual noting safety procedures.</li> <li>- Drain coolant from engine.</li> <li>- Remove upper and lower radiator hoses.</li> <li>- Remove mounting bolts.</li> <li>- Remove radiator.</li> <li>- Locate leaks by pressure testing.</li> <li>- Check radiator by pressure testing.</li> <li>- Inspect radiator cap and reservoir tank.</li> <li>- Replace radiator.</li> <li>- Replace upper and lower radiator hoses.</li> <li>- Refill radiator with coolant.</li> <li>- Test pressure system for leaks.</li> <li>- Operate engine until it reaches normal operating temperature.</li> <li>- Recheck coolant level.</li> </ul>
3.	Check Thermostat valve	<ul style="list-style-type: none"> <li>- Drain cooling water.</li> <li>- Remove thermostat housing and thermostat.</li> <li>- Clean gasket surfaces.</li> <li>- Check thermostat valve for operation.</li> <li>- Install thermostat and housing using new gasket.</li> <li>- Refill cooling system to proper level with coolant.</li> <li>- Test pressure system for leaks.</li> <li>- Operate engine until it reaches normal operating temperature.</li> <li>- Recheck coolant level.</li> </ul>

4.	Check / change water pump	<ul style="list-style-type: none"> <li>- Consult service manual noting safety procedures.</li> <li>- Drain cooling system.</li> <li>- Disconnect lower radiator hose and pump.</li> <li>- Remove fan pulley and fan hub.</li> <li>- Remove pump by pass hose if equipped.</li> <li>- Remove water pump.</li> <li>- Clean block surface of all old gaskets.</li> <li>- Disassemble pump according to manufacturer's recommended procedures.</li> <li>- Clean all parts and gasket mating surfaces.</li> <li>- Check water pump kit, impeller, shaft and bearings for wear.</li> <li>- Reassemble pump using new parts according to manufacturer's recommended procedures and specifications.</li> <li>- Install water pump using new gasket.</li> <li>- Refill cooling system to proper level with coolant.</li> <li>- Test pressure system for leaks.</li> <li>- Operate engine until it reaches normal operating temperature.</li> <li>- Recheck coolant level.</li> </ul>
5.	Check/change Coolant temp. sensor	<ul style="list-style-type: none"> <li>- Check the ECTS by monitoring live data form the scanner while engine running.</li> <li>- Remove the ECTS from the installed Position.</li> <li>- Check ECTS by measuring change in Resistance while Temperature change.</li> <li>- Install / Change ECTS and connect connector.</li> </ul>
6.	Check / change Oil Cooler	<ul style="list-style-type: none"> <li>- Consult service manual noting safety procedures.</li> <li>- Clean external surface of cooler and surrounding engine area.</li> <li>- Drain oil form oil cooler if necessary.</li> <li>- Disconnect lube oil inlet and outlet lines and cap ends of lines.</li> <li>- Remove cooler.</li> <li>- Install new cooler.</li> <li>- Reconnect oil lines using new gaskets or seals.</li> <li>- Add oil to crankcase if necessary.</li> <li>- Operate engine and check for oil leaks.</li> <li>- Stop engine and check oil level and correct as necessary.</li> </ul>
7.	Replace Coolant	<ul style="list-style-type: none"> <li>- Consult service manual noting safety procedures.</li> </ul>

		<ul style="list-style-type: none"> <li>- Clean external surface of cooler and surrounding engine area.</li> <li>- Drain oil form oil cooler if necessary.</li> <li>- Disconnect lube oil inlet and outlet lines and cap ends of lines.</li> <li>- Remove cooler.</li> <li>- Install new cooler.</li> <li>- Reconnect oil lines using new gaskets or seals.</li> <li>- Add oil to crankcase if necessary.</li> <li>- Operate engine and check for oil leaks.</li> <li>- Stop engine and check oil level and correct as necessary.</li> </ul>
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## B. Repair Fuel System

S. N.	Assignments	Skills
1.	Identify and locate Fuel System Components	<ul style="list-style-type: none"> <li>- Identify and locate following Fuel System Components</li> <li>- In Diesel Engines – Fuel feed pump, fuel filter, Inline /distributor type Fuel pump, Injectors , In CRDI Engines – Fuel Pump , High pressure pump, injector, common rail, rail pressure sensor, fuel pressure control valves,</li> <li>- In Petrol Engines- in tank fuel pump, Fuel lines, Petrol filter, fuel pressure relief valve, Injectors.</li> </ul>
2.	Replace Injectors	<ul style="list-style-type: none"> <li>- Locate and gain access to the injector(s).</li> <li>- Clean the area around the fuel injector(s).</li> <li>- Pull or plug the fuel or oil leakage lines as required per manufacturer's procedure.</li> <li>- Remove any electrical connections if used.</li> <li>- Remove the fuel line at the injector nozzle at the injection pump using the special equipment as required by manufacturer.</li> <li>- Cap the fuel lines and injection pump openings.</li> <li>- Loosen the fuel line clamp and remove the fuel line as per manufacturer's procedure.</li> <li>- Remove the injector(s) as per manufacturer's procedure and specifications and mark the injector for replacement.</li> <li>- Plug the cylinder block injector nozzle opening if more injectors are removed.</li> <li>- Clean the injector nozzle opening in the cylinder block.</li> <li>- Apply a copper-based, anti-seize compound</li> </ul>

		<p>to the nozzle threads.</p> <ul style="list-style-type: none"> <li>- Remove the protective plug from the cylinder block.</li> <li>- Install injector nozzle(s) into the original positions as per manufacturer's specifications.</li> <li>- Remove the protective caps from the fuel lines, injector pump and injector nozzles.</li> <li>- Install fuel lines, nozzle/fuel line clamps.</li> <li>- Reattach electrical connections.</li> <li>- Reconnect the fuel or oil leakage lines.</li> <li>- Bleed the fuel system.</li> <li>- Reinstall any parts removed to gain access to the nozzle.</li> <li>- Start the engine, check for leakage and correct as necessary.</li> </ul>
3.	Replace Fuel Tank	<ul style="list-style-type: none"> <li>- Disconnect the negative battery terminal.</li> <li>- Drain the fuel system as necessary per manufacturer's procedure.</li> <li>- Raise the back of the vehicle and safety support on jack stands or hoist.</li> <li>- Disconnect fuel lines and electrical connections.</li> <li>- Disconnect fuel filler tube.</li> <li>- Support the fuel tank.</li> <li>- Remove the fuel tank attachment hardware and tank.</li> <li>- Remove and clean components from old fuel tank.</li> <li>- Clean the components with correct o-ring on the new fuel tank per manufacturer's procedure.</li> <li>- Install fuel tank and attachment hardware.</li> <li>- Reconnect fuel lines and electrical connections.</li> <li>- Reconnect fuel filler tube.</li> <li>- Fill fuel tank and check for leaks.</li> <li>- Pressurize the fuel system and check for leaks per manufacturer's procedures.</li> <li>- Lower the vehicle off the jack stands or hoist.</li> <li>- Reconnect the negative battery terminal</li> </ul>
4.	Replace Fuel Feed Pump	<ul style="list-style-type: none"> <li>- Locate and gain access to fuel pump.</li> <li>- Disconnect and plug fuel lines.</li> <li>- Remove fuel pump fastening hardware and remove pump.</li> <li>- Clean fuel pumps mounting area of old gasket material and foreign matter.</li> <li>- Install replacement fuel pump and mounting hardware.</li> </ul>

		<ul style="list-style-type: none"> <li>- Reconnect fuel lines.</li> <li>- Reinstall any components that were removed to gain access to the fuel pump.</li> <li>- Start engine and check for leaks.</li> </ul>
5.	Replace Fuel Pump (Electrical type- in tank)	<ul style="list-style-type: none"> <li>- Disconnect the negative battery terminal.</li> <li>- Depressurize the fuel system.</li> <li>- Drain as much fuel out of the fuel tank by pumping out through the filler neck.</li> <li>- Raise the back of the vehicle and support on jack stands.</li> <li>- Disconnect the fuel supply, return and vent lines from the frame of the vehicle.</li> <li>- Disconnect the wiring harness from the fuel pump.</li> <li>- Support the fuel tank, loosen and remove the mounting straps.</li> <li>- Remove the fuel tank.</li> <li>- Disconnect the fuel lines and wiring harness from the pump flange.</li> <li>- Clean the outside of the mounting flange and retaining ring.</li> <li>- Remove the fuel pump lock ring per manufacturer's procedures.</li> <li>- Remove the fuel pump.</li> <li>- Clean the pump mounting surfaces.</li> <li>- Install the sealant, new fuel pump and lock ring.</li> <li>- Reconnect the fuel lines and wiring harness to the pump flange.</li> <li>- Install the fuel tank.</li> <li>- Support the fuel tank, replace and tighten the mounting straps.</li> <li>- Reconnect the wiring harness to the fuel pump.</li> <li>- Reconnect the fuel supply, return and vent lines to the vehicle frame.</li> <li>- Lower the vehicle off the jack stands.</li> <li>- Reconnect the negative battery terminal.</li> <li>- Pressurize the fuel system and check fittings for leaks.</li> <li>- Start the engine and check for leaks.</li> </ul>
6.	Set Diesel fuel injection pump timing (Distributor type)	<ul style="list-style-type: none"> <li>- Disconnect the negative battery terminal.</li> <li>- Remove components as necessary to gain access to the injection pump.</li> <li>- Remove the injection pump distributor head plug bolt and sealing washer or equivalent as per manufacturer's procedure and specifications.</li> </ul>

		<ul style="list-style-type: none"> <li>- Install static timing gauge with dial indicator, so that indicator pointer is in contact with the injection pump plunger as per manufacturer's procedure.</li> <li>- Remove the timing mark cover from transmission housing.</li> <li>- Align timing mark with no. 1 piston at TDC of compression stroke with mark on the rear engine cover plate.</li> <li>- Rotate the crankshaft pulley slowly, counterclockwise until the dial indicator stops moving as per manufacturer's procedure and specifications.</li> <li>- Set the dial gauge with zero position.</li> <li>- Turn the crankshaft clockwise until crankshaft-timing mark aligns with indicator pin.</li> <li>- Check the dial indicator reading as per manufacturer's specifications.</li> <li>- Loosen the pump mounting bolts and rotate the pump toward the engine to advance the timing and away from the engine to retard the timing until the reading is within the manufacturer's specifications.</li> <li>- Tighten the pump mounting bolts if the reading is within specifications.</li> <li>- Repeat Performance steps 6 to 11 to make sure that the timing is adjusted correctly.</li> <li>- Remove the dial indicator and adopter.</li> <li>- Install the injection pump distributor head plug or equivalent as per manufacturer's procedure and specifications.</li> <li>- Connect the negative battery terminal.</li> <li>- Run the engine, check and adjust the idle RPM, if necessary.</li> <li>- Check for fuel leaks.</li> </ul>
7.	Bleed fuel system (Fuel line air Remove- Diesel Engine)	<ul style="list-style-type: none"> <li>- Determine whether the fuel injection system is mechanical or electrical according to manufacturer's specifications. Use scanner in Electronic Fuel injection system.</li> <li>- Loosen connection at fuel filter outlet, and pump hand primer until fuel flows from connections.</li> <li>- Tighten connection at fuel filter outlet.</li> <li>- Loosen fuel pump outlet line and pump hand primer until fuel flows from connection</li> <li>- Loosen fuel line connections at fuel injectors and crank engine until fuel appears.</li> </ul>

		<ul style="list-style-type: none"> <li>- Retighten the connection.</li> <li>- Start the engine and operate for period of time necessary to purge remaining air from lines as per manufacturer's procedure.</li> </ul>
8.	Replace fuel level sending unit.	<ul style="list-style-type: none"> <li>- Disconnect the negative battery terminal.</li> <li>- Depressurize the system per manufacturer's procedures.</li> <li>- Locate fuel level sending unit.</li> <li>- Remove fuel tank if necessary to gain access to the sending unit.</li> <li>- Clean sending unit area to prevent dirt from entering the fuel tank.</li> <li>- Siphon fuel as necessary to lower the fuel level below the sending unit opening.</li> <li>- Remove the sending unit fuel lines, electrical connections and attachment hardware.</li> <li>- Remove the sending unit.</li> <li>- Clean the sending unit mounting surface. Do not get dirt into the fuel tank.</li> <li>- Install replacement sending unit, gaskets or seals per manufacturer's procedures.</li> <li>- Reattach fuel lines and electrical connections.</li> <li>- Pressurize the fuel system and check for leaks per manufacturer's procedures.</li> <li>- Reinstall any components that were removed to gain access to the fuel-sending unit.</li> <li>- Reconnect the negative battery terminal.</li> <li>- Check out put voltage and/or gauge while filling the tank.</li> </ul>
9.	Check Fuel Pump Pressure	<ul style="list-style-type: none"> <li>- Check Fuel Pump Pressure using pressure gauge with standard procedure recommended by manufacturer.</li> </ul>

### C. Repair Lubricating System

S. N.	Assignments	Skills
1.	Identify and locate Lubricating system Components	<ul style="list-style-type: none"> <li>- Identify and locate Lubricating system Components – Engine oil, filter, oil cooler, oil galleries, oil pump, oil pressure sensor and warning lamp</li> </ul>
2.	Replace Engine Oil and Filter	<ul style="list-style-type: none"> <li>- Place a clean tray under the drain plug.</li> <li>- Unscrew the drain plug.</li> <li>- Remove the drain plug.</li> <li>- Drain the engine oil in a jar or tray.</li> <li>- Remove oil filter.</li> <li>- Replace oil filter.</li> <li>- Plug the drain plug when oil stops dropping.</li> <li>- Tighten the drain plug as per specified torque</li> </ul>

		<p>according to the service manual. (Don't over tight)</p> <ul style="list-style-type: none"> <li>- Refill the specified grade of engine oil to the required level.</li> <li>- Wait 5 to 10 minutes for checking oil level.</li> <li>- Lift the dipstick and wipe it.</li> <li>- Check the oil level.</li> <li>- Refill the oil if the level is low.</li> <li>- Cap the filler cap.</li> <li>- Keep the jar or tray in proper place.</li> </ul>
3.	Replace Oil Cooler	<ul style="list-style-type: none"> <li>- Consult service manual noting safety procedures.</li> <li>- Clean external surface of cooler and surrounding engine area.</li> <li>- Drain oil form oil cooler if necessary.</li> <li>- Disconnect lube oil inlet and outlet lines and cap ends of lines.</li> <li>- Remove cooler.</li> <li>- Install new cooler.</li> <li>- Reconnect oil lines using new gaskets or seals.</li> <li>- Add oil to crankcase if necessary.</li> <li>- Operate engine and check for oil leaks.</li> <li>- Stop engine and check oil level and correct as necessary.</li> </ul>
4.	Replace Oil Pump	<ul style="list-style-type: none"> <li>- Locate the oil pump in the engine.</li> <li>- Remove all parts to gain access to remove oil pump.</li> <li>- Remove oil pump assembly.</li> <li>- Remove oil filter.</li> <li>- Clean oil strainer.</li> <li>- Disassemble the oil pump according to manufacturer's procedures.</li> <li>- Inspect the worn parts to be replaced.</li> <li>- Examine to determine reason for failure before replacing with new pump.</li> <li>- Get replaced parts or new pump.</li> <li>- Reassemble the oil pump as per service manual's procedures and specifications.</li> <li>- Install the oil strainer and oil pump to the engine.</li> <li>- Connect the oil supply pipes.</li> <li>- Replace all the parts that were removed to gain access to the oil pump.</li> </ul>
5.	Perform oil pressure tests	<ul style="list-style-type: none"> <li>- Perform oil pressure, record and compare to manufacturers' information.</li> </ul>

## D. Engine Overhaul

S. N.	Assignments	Skills
1.	Dismantle Engine	<ul style="list-style-type: none"> <li>- Remove Engine Cover</li> <li>- Remove Camshaft Cover</li> <li>- Remove Inlet Manifold</li> <li>- Remove Exhaust Manifold</li> <li>- Remove all electrical and accessories attached to the engine.</li> <li>- Remove Timing belt</li> <li>- Remove Cylinder Head and Gasket</li> <li>- Remove Camshaft / Gear</li> <li>- Remove valves from cylinder head.</li> <li>- Remove Oil Pan</li> <li>- Remove Oil Pump</li> <li>- Remove Engine Mounting</li> <li>- Remove Rear timing belt cover</li> <li>- Remove connecting Rods/Pistons</li> <li>- Remove Crankshaft</li> <li>- Remove Crankshaft Bearing</li> <li>- Clean all components.</li> </ul>
2.	Identify Engine Components	<p><b>Cylinder Head</b></p> <ul style="list-style-type: none"> <li>- Oil Filler Cap</li> <li>- Engine Cover</li> <li>- Camshaft Cover</li> <li>- Camshaft Cover Gasket</li> <li>- Camshaft Cover Bolt</li> <li>- Hydraulic lash Adjuster</li> <li>- Tappet, pushrod, rocker arm</li> <li>- Valve Key/cullet</li> <li>- Valve Spring Cap</li> <li>- Valve Spring</li> <li>- Valve Stem Seal</li> <li>- CVT (continuous variable timing) assembly</li> <li>- EGR Vacuum Hose</li> <li>- EGR Valve with Gasket</li> <li>- EGR Valve Adaptor with Gasket</li> <li>- Cylinder Head gasket</li> <li>- Front Camshaft Cap</li> <li>- Valve Guide</li> <li>- spark Plug/glow plug</li> <li>- Freeze/expansion Plug</li> <li>- Oil Duct Cap</li> <li>- Intake Valve</li> <li>- Exhaust Valve</li> <li>- Cylinder Head Gasket</li> <li>- Engine Coolant Temperature Sensor</li> </ul>

		<ul style="list-style-type: none"> <li>- Heat Take Off Pipe</li> <li>- Camshaft</li> <li>- Camshaft Seal</li> <li>- Thermostat valve</li> <li>- Cam shaft position sensor</li> <li>- PCV (positive crankcase ventilation)</li> </ul> <p><b>Cylinder Block</b></p> <ul style="list-style-type: none"> <li>- Piston Rings Set</li> <li>- Piston</li> <li>- Piston Pin</li> <li>- Connecting Rod</li> <li>- Connecting Rod Bearing Set</li> <li>- Oil Level Gauge Stick</li> <li>- Gauge Stic Tube</li> <li>- Sleeve</li> <li>- Clutch Housing Sleeve</li> <li>- Cylinder Block</li> <li>- Bypass Valve</li> <li>- Oil Filter</li> <li>- Oil Pump</li> <li>- Knock Sensor</li> <li>- Crank shaft position sensor</li> <li>- Fly Wheel (M/T)</li> <li>- Torque converter (A/T)</li> <li>- Crank Shaft Bearings Set</li> <li>- Crank Shaft</li> <li>- Transmitter Disc</li> <li>- Crankshaft Bearing Cap</li> <li>- Oil Pan</li> <li>- Thrust Washer</li> <li>- Oil Pan Drain Plug</li> <li>- Oil Pump assembly</li> <li>- Pressure Relief Valve</li> <li>- Oil Pressure Switch</li> <li>- Sleeve/liner</li> <li>- Oil Suction Pipe Bracket</li> <li>- Oil Suction Pipe</li> </ul> <p><b>Exhaust and Inlet manifold</b></p> <ul style="list-style-type: none"> <li>- Oxygen Sensor</li> <li>- Heat Shield</li> <li>- Exhaust Manifold</li> <li>- Exhaust Manifold Gasket</li> <li>- Intake Manifold</li> <li>- Throttle body</li> <li>- Intake Air Tube</li> <li>- Breathe Hose</li> <li>- Air cleaner Assembly</li> </ul>
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		<ul style="list-style-type: none"> <li>- Air cleaner Element</li> <li>- Resonator</li> <li>- Air Inter Hose</li> </ul> <p><b>Timing Belt</b></p> <ul style="list-style-type: none"> <li>- Water Pump</li> <li>- Timing Belt Rear Cover</li> <li>- Camshaft Position Sensor</li> <li>- Auto Tensioner</li> <li>- Camshaft Gear</li> <li>- Idler pulley</li> <li>- Crankshaft Gear</li> <li>- Timing Belt</li> <li>- Timing Belt Front Upper Cover</li> <li>- Timing Belt Front Lower Cover</li> <li>- Crankshaft Pulley</li> <li>- Crankshaft Position Sensor</li> </ul>
3.	Inspect Engine Components	<ul style="list-style-type: none"> <li>- Measure Engine Components : Ovality and taperness of bore, piston, crankshaft,</li> <li>- Inspect engine components</li> <li>- Check connecting rod side clearance</li> <li>- Check the connecting rod bearing cap oil clearance</li> <li>- Check fit between piston and piston pin</li> <li>- Check side clearance between piston and connecting rod</li> <li>- Check the piston-to-cylinder clearance by calculating the difference between the cylinders bore inner diameter and the piston outer diameter.</li> <li>- Inspect the piston ring side clearance.</li> <li>- Inspect the piston ring end gap.</li> <li>- Assemble the piston rings.</li> </ul>
4.	Check/ Change Turbocharger	<ul style="list-style-type: none"> <li>- Change the turbocharger as per manufactures standard procedure</li> </ul>
5.	Check change EGR Valve	<ul style="list-style-type: none"> <li>- Change EGR Valve as per manufactures standard procedure</li> </ul>
6.	Inspect/ Change Glow Plug	<ul style="list-style-type: none"> <li>- Remove nuts and glow plug connector</li> <li>- Check the continuity of glow plug</li> <li>- Inspect glow plug relay continuity</li> <li>- Inspect relay operation</li> <li>- Inspect glow plug resistor</li> <li>- Install glow plug</li> <li>- Heat and crank the engine</li> <li>-</li> </ul>
7.	Check/ change Spark Plug	<ul style="list-style-type: none"> <li>- Disconnect negative terminal of battery</li> <li>- Remove high tension cord</li> <li>- remove spark plug</li> <li>- Check electrode wear</li> </ul>

		<ul style="list-style-type: none"> <li>- Check and clean carbon deposits</li> <li>- Adjust the plug gap as per specification.</li> <li>- Check insulator damage</li> <li>- Change spark plug if found faulty</li> <li>- Reverse the process of removal</li> </ul>
8.	Assemble Engine	<ul style="list-style-type: none"> <li>- Install Crankshaft Bearing</li> <li>- Install crankshaft</li> <li>- Install Main Bearing Caps</li> <li>- Install Pistons and Connecting rods</li> <li>- Install Rear Timing Belt Cover</li> <li>- Install Oil Pump</li> <li>- Install Oil pan</li> <li>- Install valve assembly</li> <li>- Install Cylinder Head and gasket</li> <li>- Install Exhaust Manifold</li> <li>- Install Inlet Manifold</li> <li>- Install Camshaft and Gear</li> <li>- Install Timing Belt and cover</li> <li>- Install Camshaft Cover</li> <li>- Install all electrical and accessories</li> <li>-</li> </ul>
9.	Set Valve timing	<ul style="list-style-type: none"> <li>- Set crankshaft and piston assembly as per manufacturer's specifications and procedures.</li> <li>- Reassemble oil pump using new components from overhaul kit as required.</li> <li>- Install camshaft, pushrod, tappet, oil pump, distributor, fuel pump or FI pump.</li> <li>- Install head gasket and cylinder head assembly.</li> <li>- Install timing gear or sprockets of crankshaft and camshaft.</li> <li>- Rotate the camshaft to make intake valve of no. 1 cylinder must be in compression stroke.</li> <li>- Rotate the crankshaft in order to that no. 1 piston is in TDC position.</li> <li>- Align the marks of crank/camshaft timing gear and fuel injection pump timing gear as per manufacturer's specifications and procedures.</li> <li>- Install timing belt or chain and set timing.</li> <li>- Install timing cover bracket and pulley.</li> <li>- Remount the engine to the chassis.</li> <li>- Replace all parts previously removed to gain access to overhaul engine.</li> <li>- Make all adjustments during reassembly as per manufacturer' specifications.</li> <li>- Reconnect throttle linkage.</li> <li>- Reconnect hoses and electrical connectors.</li> </ul>

		<ul style="list-style-type: none"> <li>- Reconnect the fuel line.</li> <li>- Refill engine oil.</li> <li>- Reconnect the negative battery terminal.</li> <li>- Adjust valve/tappet clearance per manufacturer's specifications and procedures.</li> <li>- Start the engine and warm it up to normal operating temperatures.</li> <li>- Tune up engine to manufacturer's specifications following manufacturer's procedures.</li> </ul>
10.	Adjust tappet clearance	<ul style="list-style-type: none"> <li>- Collect required tools and materials.</li> <li>- Consult service manual for specifications and safety precautions.</li> <li>- Clean components as necessary.</li> <li>- Run engine to normal operating temperature.</li> <li>- Shut down engine.</li> <li>- Remove rocker arm cover or tappet cover.</li> <li>- Determine the intake and exhaust valve clearly because the clearance is usually different for both.</li> <li>- Turn the engine pulley until the first cylinder is at top dead center (TDC) of its compression stroke.</li> <li>- Check the valve clearance when the piston is at TDC of compression stroke.</li> <li>- Adjust the valve clearance with a feeler gauge.</li> <li>- Loosen the lock nut and turn adjusting screw to and fro until the correct valve clearance according to the specifications is obtained.</li> <li>- Tighten the lock nut and the adjusting screw must not turn while tightening.</li> <li>- Rotate the engine in its firing order.</li> <li>- Repeat performance steps 7 to 12 for each cylinder to adjust both intake and exhaust valves.</li> <li>- Install new gasket and tappet cover.</li> <li>- Check again after running in.</li> <li>-</li> </ul>
11.	Inspect Cylinder compression pressure	<ul style="list-style-type: none"> <li>- Inspect Cylinder compression pressure in dry and wet conditions</li> </ul>

## E. Repair Heating Ventilation and Air Condition System

S. N.	Assignments	Skills
1.	Identify and Locate HVAC Components	<ul style="list-style-type: none"> <li>- Identify and Locate HVAC Components.</li> </ul>
2.	<b>Change AC filter.</b>	<ul style="list-style-type: none"> <li>- Identify and locate AC filter.</li> <li>- Remove glove box.</li> <li>- Open grommets of AC filter box.</li> <li>- Remove AC filter element from housing.</li> <li>- Clean or replace the filter as necessary.</li> <li>- Connect all the parts in reverse order.</li> <li>- Operate AC for proper functioning.</li> </ul>
3.	AC Gas Leakage Check	<ul style="list-style-type: none"> <li>- Visual inspection of High pressure and low pressure pipe.</li> <li>- Inspect for condenser and compressor breakage.</li> <li>- Check for vacuum gauge reading in-ve value and mark it. (While connecting High pressure &amp; low pressure line to machine)</li> <li>- Check for gauge reading stable for some a while of holding time.</li> <li>- Interpret the result, unstable gauge reading indicate system leakage.</li> <li>- Repair &amp; replace faulty components.</li> <li>- Inspect for fittings, their setting faces for damage, replace if necessary.</li> <li>- Verify repair.</li> </ul>
4.	Check / Change Compressor	<ul style="list-style-type: none"> <li>- Select &amp; use necessary tools.</li> <li>- Disconnect the negative cable from battery.</li> <li>- Recover the refrigerant with recovery machine.</li> <li>- Loosen the drive belt.</li> <li>- Remove bolts and disconnect suction &amp; discharge line from compressor.</li> <li>- Disconnect compressor clutch connector &amp; mounting bolts and the compressor.</li> <li>- Check pulley bearing play, replace if it is noisy or excessive play/drag.</li> <li>- Check operation of magnetic clutch by connecting battery power to appropriate terminals.</li> <li>- Check for electric control valve if the compressor is clutch less type (Optional).</li> <li>- Install in the reverse order of removal.</li> <li>- Adjust drive belt, change the refrigerant system.</li> <li>- Verify the repair.</li> </ul>
5.	Check / change Condenser	<ul style="list-style-type: none"> <li>- Visually inspect condenser fins for dogging, damage, bond &amp; leakage.</li> </ul>

		<ul style="list-style-type: none"> <li>- Recover the refrigerant with recycling matching before removing condenser.</li> <li>- Remove nuts &amp; then disconnect discharge and liquid line from the condenser.(remove FR bumper if needed)</li> <li>- Remove the condenser mounting bolts and then condenser.</li> <li>- Check radiator for jam and damage (compressed air can be blower from one side and inspect it comes out from another side).</li> <li>- Installation is reverse process.</li> <li>- Verify repair.</li> </ul>
6.	Check / Change Blower Fan	<ul style="list-style-type: none"> <li>- Disconnect the negative battery terminal.</li> <li>- Remove crash pad (dash board).</li> <li>- Remove blower by loosen mounting bolts and screws (remove cross bar if needed in some cars).</li> <li>- Disconnect the blower motor after loosening the mounting screw.</li> <li>- Supply battery voltage to check for blower motor rotation.</li> <li>- Check for vary in blower motor speed according to input given from blower motor speed control knob.</li> <li>- Also check for blower resistor.</li> <li>- Installation of blower motor and blower unit in reverse order.</li> <li>- Verify repair by functional test.</li> </ul>
7.	Check / Change Heater Core	<ul style="list-style-type: none"> <li>- Select &amp; use necessary tools.</li> <li>- Disconnect the negative battery terminal.</li> <li>- Recover the refrigerant, drain engine coolant.</li> <li>- Disconnect the inlet &amp; outlet bushes from the heater unit, (outside of dash panel).</li> <li>- Remove crash pad (dash board).</li> <li>- Remove blower unit from heater unit.</li> <li>- Remove evaporator core.</li> <li>- Visual inspect evaporator for crack &amp; then air leakage.</li> <li>- Install the heater core in reverse order of removal.</li> <li>- Verify repair.</li> </ul>
8.	Check/ Service Air flow Control System	<ul style="list-style-type: none"> <li>- Recover refrigerant and Evacuate air Conditioning system</li> <li>- Access and inspect for faulty components such as blower motor, cabin filter, knob vent, bend door etc.</li> <li>- Remove, repair and replace faulty components</li> </ul>

		<p>such as control units, connector, blend door, connector, blower motor and resistors.</p> <ul style="list-style-type: none"> <li>- Clean Air flow system with deodorizer.</li> <li>- Complete repair by verifying system function and performance.</li> </ul>
9.	Diagnose and Repair Heating System	<ul style="list-style-type: none"> <li>- Verify operating conditions</li> <li>- Remove and replace faulty components</li> </ul>
10.	Check/ change Refrigerant line	<ul style="list-style-type: none"> <li>- Discharge refrigerant from refrigeration system</li> <li>- Open suction and discharge hose from compressor, discharge hose and liquid tube from condenser and tube from expansion valve to evaporator.</li> <li>- Check and inspect hose and tubes for damages, seal seating position and condition of fasteners.</li> <li>- Evacuate air in refrigeration system and charge refrigerant.</li> <li>- Tighten the bolt and nuts with specified torque.</li> </ul>
11.	Diagnose and Repair refrigerant system	<ul style="list-style-type: none"> <li>- Verify problem and visual inspection</li> <li>- Perform leak test.</li> <li>- Verify operation condition of electronically controlled system</li> <li>- Interpret Pressure gauge readings, DTC's, live data to determine conditions of system and components.</li> <li>- Recover refrigerant and evacuate air conditioning system.</li> <li>- System components are inspected for wear, damage and leaks.</li> <li>- Remove and replace faulty components.</li> <li>- Recharge system.</li> </ul>

### F. Vehicle Servicing

S. N.	Assignments	Skills
1.	Perform Common Occupational Skill	<ul style="list-style-type: none"> <li>- Perform Safety related functions</li> <li>- Maintain safe working environment</li> <li>- Uses personnel protective equipment and safety equipment</li> <li>- Use tools, equipment and documentation</li> <li>- Uses hoisting and lifting equipment</li> </ul>
2.	General Check Up	<ul style="list-style-type: none"> <li>- Inspect exterior condition of Vehicle for Scratch, dent, crack, corrosion etc.</li> <li>- Inspect all exterior and interior lights</li> <li>- Inspect Wiper, wiper blade and Washer</li> <li>- Inspect Brake, Clutch and accelerator pedal for smooth operation.</li> <li>- Inspect level and leakages of Engine oil, coolant,</li> </ul>

		<p>brake oil and steering oil.</p> <ul style="list-style-type: none"> <li>- Inspect all bolt tightening condition from underbody.</li> <li>- Inspect vehicle management system using Scanner.</li> </ul>
2.	Perform Vehicle washing	<ul style="list-style-type: none"> <li>- Park the vehicle in service bay.</li> <li>- Apply hand brake or place choke to the wheel.</li> <li>- Clean the interior of the vehicle, use vacuum cleaner for cleaning interior floor</li> <li>- Lift the hydraulic ramp as required height.</li> <li>- Adjust the pressure of water spray nozzle in water pump or hosepipe.</li> <li>- Wash the vehicle thoroughly by using spray nozzle.</li> </ul> <p><b>Clean/ wash the floor mats and mattress.</b></p> <ul style="list-style-type: none"> <li>- Wipe up the body of the vehicle with soft cloth and liquid soap or detergent.</li> <li>- Wash/Remove dry soil or mud under the chassis.</li> <li>- Wipe the wet water with soft cloth.</li> <li>- Wax the dashboard interior.</li> </ul>
3.	Lubricate Chassis	<ul style="list-style-type: none"> <li>- Pack the grease to the grease gun.</li> <li>- Keep the grease gun to the greasing nipple.</li> <li>- Pump the grease gun to the nipple 2 to 4 times for greasing.</li> <li>- Change the greasing nipple if the greasing not complete.</li> <li>- Repeat the Performance steps for following greasing points.</li> <li>- remote gear shifting linkage, king pins, tie rod ends/ball joints, drag links ends, steering knuckle joints, front spring pins, rear spring pins, propeller shaft U-joints, propeller shaft sliding yoke, parking brake intermediate shaft bushes, brake double levers, brake shaft bushes, clutch pedal bushing.</li> </ul> <p><b>For Oiling</b></p> <ul style="list-style-type: none"> <li>- Fill lube oil to the oil clean.</li> <li>- Locate the oiling points to the vehicle.</li> <li>- Clean the area of oiling and surroundings.</li> <li>- Oil to the points by using oilcan.</li> <li>- Repeat the Performance steps for following points.</li> <li>- Oil control to injection points.</li> <li>- Oil ball joints of engine exhaust brake linkage if fitted.</li> <li>- Oil central flap hinges and stay rods.</li> <li>- Oil to the linkage of clutch actuation and parking brake.</li> <li>- Oil to the door hinges.</li> </ul>
3.	Inspect maintain Tyre Pressure	<ul style="list-style-type: none"> <li>- Check the air pressure of the tyre.</li> <li>- Inflate tyre if the pressure is low.</li> <li>- Deflate tyre if the tyre is over inflation.</li> <li>- Maintain the pressure according to specification.</li> <li>- Read the air pressure gauge on the dashboard.</li> <li>- Adjust air valve if required.</li> </ul>
4.	Adjust Clutch Pedal Free Play	<ul style="list-style-type: none"> <li>- Determine the types of clutch to be adjusted.</li> <li>- Collect all the required tools and materials.</li> <li>- Check the fluid in clutch cylinder reservoir.</li> <li>- Top up if the level is low.</li> <li>- Bleed the air if required.</li> <li>- Check the clutch pedal free play.</li> <li>- Adjust the clutch cylinder push rod if the pedal free play is not specified.</li> <li>- Adjust the slave cylinder push rod if applicable.</li> </ul>

		<ul style="list-style-type: none"> <li>- In case of cable type clutch, Adjust free play by turning adjusting nut as specified in the service manual</li> <li>- Check the clutch plate, clutch cylinder and other components if the adjustment not works.</li> </ul>
5.	Change Air Filter	<ul style="list-style-type: none"> <li>- Remove air cleaner element as per manufacturer's procedure.</li> <li>- Strike dry element bottom side down on floor or hard surface.</li> <li>- Blow out dirt with approved blowgun, blowing from inside out.</li> <li>- Inspect filter by holding shop light inside filter and verifying that light is visible through the filter element.</li> <li>- Reinstall air cleaner element into the air cleaner assembly.</li> </ul>
6.	Clean AC Filter	<ul style="list-style-type: none"> <li>- Identify and locate AC filter.</li> <li>- Remove glove box.</li> <li>- Open grommets of AC filter box.</li> <li>- Remove AC filter element from housing.</li> <li>- Clean or replace the filter as necessary.</li> <li>- Connect all the parts in reverse order.</li> <li>- Operate AC for proper functioning</li> </ul>
7.	Change Engine oil and oil filter	<ul style="list-style-type: none"> <li>- Place a clean tray under the drain plug.</li> <li>- Unscrew the drain plug.</li> <li>- Remove the drain plug.</li> <li>- Drain the engine oil in a jar or tray.</li> <li>- Remove oil filter.</li> <li>- Replace oil filter.</li> <li>- Plug the drain plug when oil stops dropping.</li> <li>- Tighten the drain plug as per specified torque according to the service manual. (Don't over tight)</li> <li>- Refill the specified grade of engine oil to the required level.</li> <li>- Wait 5 to 10 minutes for checking oil level.</li> <li>- Lift the dipstick and wipe it.</li> <li>- Check the oil level.</li> <li>- Refill the oil if the level is low.</li> <li>- Cap the filler cap.</li> <li>- Keep the jar or tray in proper place.</li> </ul>
8.	Change Coolant	<ul style="list-style-type: none"> <li>- Collect required tools and materials.</li> <li>- Check the coolant level in the radiator/reservoir.</li> <li>- Inspect the coolant properties.</li> <li>- Drain the radiator if required.</li> <li>- Prepare the specified quantity of coolant/water according to service manual provided.</li> <li>- Add coolant if the level is low.</li> <li>- Check the leakage from radiator.</li> <li>- Check the radiator cap.</li> </ul>

# Auto Electricals Electronics System

(10 Weeks – 400 hours)

## A. Repair Starting System

S. N.	Assignments	Skills
1.	Identify and Locate Starting System Components	<ul style="list-style-type: none"> <li>- Identify and Locate Starting System Components</li> </ul>
2.	Inspect and Change Fuse and Relays	<ul style="list-style-type: none"> <li>- Disconnect battery negative terminal.</li> <li>- Note down carefully the positions in which the various components are fitted in order to ensure the correct replacement on reassembly.</li> <li>- Consult the service manual or wiring diagram to locate the relay or switch that you want to replace.</li> <li>- Remove cover or other components to gain access to the relay or switch</li> <li>- Remove the faulty relay or switch.</li> <li>- Check the relay or switch for continuity, voltage or resistance as per service manual.</li> <li>- Trace out the fault or defective relay or switch.</li> <li>- Replace new relay or switch with correct rating or specifications.</li> <li>- Connect battery terminal.</li> <li>- Check the operation of the relay/switch.</li> <li>-</li> </ul>
3.	Service Starter Motor	<ul style="list-style-type: none"> <li>- Consult service manual.</li> <li>- Remove battery ground terminal.</li> <li>- Remove wires to starter motor.</li> <li>- Remove starter bolts and starter motor.</li> <li>- Clean exterior of starter motor.</li> <li>- Remove cover over brushes.</li> <li>- Remove the solenoid from the starter.</li> <li>- Remove all brushes from retainers.</li> <li>- Remove commutator end plate.</li> <li>- Remove through bolts.</li> <li>- Remove drive end of housing.</li> <li>- Remove retaining ring and old drive.</li> <li>- Remove armature.</li> <li>- Inspect commutator and retainers for damage.</li> <li>- Remove bushing with appropriate puller or driver.</li> <li>- Inspect housing and shaft for wear.</li> <li>- Install new bearing and shaft.</li> <li>- Lubricate the bushings and starter drive shaft with specified lubricant.</li> <li>- Install new drive, retaining ring and brushes.</li> </ul>

		<ul style="list-style-type: none"> <li>- Pull back the brush springs with hook and insert brushes into their holders.</li> <li>- Slide in end plate.</li> <li>- Cover brushes.</li> <li>- Install the new solenoid on the starter motor.</li> <li>- Reassemble the starter motor.</li> <li>- Install starter motor.</li> <li>- Tighten starter bolts.</li> <li>- Reconnect wires to starter motor.</li> <li>- Reconnect battery negative terminal.</li> <li>- Check operation with battery.</li> <li>- Test on bench with proper power supply.</li> </ul>
4.	Replace Ignition Switch	<ul style="list-style-type: none"> <li>- Disconnect the negative battery terminal.</li> <li>- Determine the wiring circuit as per manufacturer.</li> <li>- Disconnect the electrical connectors after marking them with tape for identification when reinstalling.</li> <li>- Remove components as necessary to gain access to the ignition switch as per manufacturer's procedure and specifications.</li> <li>- Clean wiring harness connectors.</li> <li>- Test the ignition switch as manufacturer's procedures.</li> <li>- Replace new ignition switch.</li> <li>- Connect switch wires to their original location.</li> <li>- Replace all components that were removed to gain access to ignition switch.</li> <li>- Connect battery negative terminal.</li> <li>- Start the engine and check the switch operation.</li> </ul>

### **B. Repair Charging System**

<b>S. N.</b>	<b>Assignments</b>	<b>Skills</b>
1.	Identify and Locate Charging System Components	<ul style="list-style-type: none"> <li>- Identify and Locate Charging System Components</li> </ul>
2.	Service Alternator	<ul style="list-style-type: none"> <li>- Consult service manual.</li> <li>- Remove battery ground terminal.</li> <li>- Disconnect connector/wires to alternator</li> <li>- Remove alternator.</li> <li>- Clean exterior of alternator.</li> <li>- Remove through bolts.</li> <li>- Examine the position of stator output leads relative to alternator fixing lugs and lift stator from drive end bracket.</li> <li>- Clamp rotor and unscrew shaft nut.</li> <li>- Remove pulley and fan.</li> <li>- Unscrew bearing retainer plate fixing screw and remove bearing and retainer.</li> <li>- Remove suppression capacitor fixing screw and</li> </ul>

		<ul style="list-style-type: none"> <li>remove capacitor.</li> <li>- Unscrew rectifier-fixing screw and remove baffle plate.</li> <li>- Remove slip ring end bearing.</li> <li>- Remove slip ring end bracket assembly and separate stator and rectifier by desoldering the stator connecting lead between field connector plates to brush box terminal.</li> <li>- Disconnect regulator leads, unscrew and remove regulator.</li> <li>- Remove brush box by unscrewing the screw from slip ring end bracket and lift off brush box assembly.</li> <li>- Clean all parts carefully.</li> <li>- Check parts for weariness and replace if necessary.</li> <li>- Reassemble the alternator components as reversal of the dismantling procedure.</li> <li>- Install the alternator.</li> <li>- Reconnect wires to alternator and regulator.</li> <li>- Reconnect battery terminal.</li> <li>- Test the alternator performance.</li> <li>- Test on bench with proper power supply</li> </ul>
3.	Replace Battery and Charge Battery	<ul style="list-style-type: none"> <li>- Disconnect both battery terminals, always do negative terminal first for safety practice.</li> <li>- Remove bracket, mounting clamp or cover to gain access to the battery.</li> <li>- Clean battery external and top cover.</li> <li>- Lift the battery from chassis/body.</li> <li>- Dispose the old battery properly.</li> <li>- Check the electrolyte level of new battery.</li> <li>- Add sulphuric acid or distilled water as per manufacturer's instructions and procedures.</li> <li>- Plug the vent plugs properly.</li> <li>- Replace the new battery.</li> <li>- Clamp or secure the battery in battery tray or case.</li> <li>- Connect the battery terminals, always connect positive terminal first.</li> <li>- Use petroleum jelly or Vaseline or white grease to the terminal post.</li> <li>- Start the vehicle and check the battery performance.</li> </ul>

### C. Repair Ignition System

S. N.	Assignments	Skills
1.	Check / Replace Ignition Coil	<ul style="list-style-type: none"> <li>- Refer to manufacturer's service manual for specifications and procedures.</li> <li>- Disconnect terminals and high tension cord from ignition coil.</li> <li>- Test primary and secondary coil resistance.</li> <li>- Replace if needed.</li> <li>- Test the function of ignition coil as per manufacturer's specifications.</li> </ul>
2.	Check / Replace High Tension cables	<ul style="list-style-type: none"> <li>- be able to troubleshoot High tension cables</li> </ul>
3.	Identify and Locate Ignition System Components	<ul style="list-style-type: none"> <li>- Identify and Locate Ignition System Components</li> </ul>

### D. Repair Gasoline EMS

S. N.	Assignments	Skills
1.	Identify and locate Gasoline EMS Components , harness and Control module	<ul style="list-style-type: none"> <li>- Able to Identify and locate Gasoline EMS Components, harness and Control module</li> <li>- Sensors</li> <li>- Manifold absolute pressure sensor (MAPS)</li> <li>- Air temperature sensor</li> <li>- Barometric pressure sensor</li> <li>- Throttle position sensor</li> <li>- Crank shaft position sensor/rpm sensor</li> <li>- Camshaft position sensor</li> <li>- Water temperature sensor</li> <li>- Oxygen sensor</li> <li>- Knock sensor</li> <li>- Accelerator pedal position sensor</li> <li>- Brake switch</li> <li>- Clutch switch</li> <li>- Actuators</li> <li>- Idle speed control valve</li> <li>- Ignition coil</li> <li>- Purge control valve</li> <li>- Fuel injector</li> <li>- Fuel pump</li> <li>- ECU Relay</li> <li>- Fuel cut of solenoid valve</li> <li>- Check engine light</li> <li>- Malfunction indicator light (MIL)</li> <li>- Positive crankcase ventilation (PCV) valve</li> <li>- ECU and wiring harness</li> </ul>

2.	Troubleshoot Gasoline Engine EMS using Scanner	<ul style="list-style-type: none"> <li>- Locate the Diagnostic link connector (DLC).</li> <li>- Connect MPFI diagnostic tester as per manufacturer's procedures and instructions.</li> <li>- Diagnose the various sensors using scanner and multimeter.</li> <li>- Read / Clear Diagnostic Troubleshooting code (DTC's), Analyze Live/ Current Data, perform actuation test.</li> <li>- Replace new sensors if found defective but they are not recommended to be repaired.</li> </ul>
3.	Clean Throttle Body	<ul style="list-style-type: none"> <li>- Turn Ignition Switch off and disconnect battery terminals</li> <li>- Remove air filter, Resonator and intake hoses.</li> <li>- Disconnect Throttle position sensor connector and Accelerator cable.</li> <li>- Remove mounting bolts and remove throttle body from Engine.</li> <li>- Inspect operation and carbon deposits.</li> <li>- Clean throttle body (and Idle speed control actuator if installed) with carbon cleaner. Note: In case of electronic throttle control use Scanner to clean and reset referring to shop manuals.</li> <li>- Replace / Re Install throttle body in reverse order of dismount.</li> <li>- Connect battery terminals.</li> <li>- Verify proper operation.</li> <li>- Start the engine and by connecting the scanner, check the voltage output of Throttle position sensor at idle and wide open throttle. (Specification refer to shop manuals.)</li> </ul>
4.	Perform emission test using smoke analyzer	<ul style="list-style-type: none"> <li>- Perform emission test using smoke analyzer</li> </ul>

### E. Repair Diesel EMS System

S. N.	Assignments	Skills
1.	Identify and locate Diesel EMS Components , harness and Control module	<p><b>Sensors</b></p> <ul style="list-style-type: none"> <li>- Mass airflow sensor</li> <li>- Air temperature sensor</li> <li>- Barometric pressure sensor</li> <li>- Crank shaft position sensor/rpm sensor</li> <li>- Camshaft position sensor</li> <li>- Water temperature sensor</li> <li>- Oxygen sensor</li> <li>- Knock sensor</li> <li>- Rail pressure sensor</li> <li>- Fuel temperature sensor</li> <li>- Boost pressure sensor</li> </ul>

		<ul style="list-style-type: none"> <li>- Accelerator pedal position sensor</li> <li>- Brake switch</li> <li>- Clutch switch</li> <li>- Water in fuel sensor</li> </ul> <p><b>Actuators</b></p> <ul style="list-style-type: none"> <li>- Fuel injector</li> <li>- Fuel pump</li> <li>- ECU Relay</li> <li>- EGR valve</li> <li>- Air control valve</li> <li>- Fuel cut of solenoid valve</li> <li>- Check engine light</li> <li>- Malfunction indicator light (MIL)</li> <li>- High pressure pump</li> <li>- Common rail</li> <li>- Inlet metering valve (IMV)</li> <li>- Positive crankcase ventilation (PCV) valve</li> </ul> <p><b>ECU and wiring harness</b></p>
2.	Troubleshoot Diesel EMS using Scanner and Multimeter	<ul style="list-style-type: none"> <li>- Locate the Diagnostic link connector (DLC).</li> <li>- Connect MPFI diagnostic tester as per manufacturer's procedures and instructions.</li> <li>- Diagnose the various sensors using scanner and multimeter.</li> <li>- Read / Clear Diagnostic Troubleshooting code (DTC's), Analyze Live/ Current Data, perform actuation test.</li> <li>- Replace new sensors if found defective but they are not recommended to be repaired.</li> </ul>
3.	Perform emission test using smoke analyzer	<ul style="list-style-type: none"> <li>- Perform emission test using smoke analyzer</li> </ul>

## F. Repair Body Electrical System

S. N.	Assignments	Skills
1.	Diagnose and Repair Power Window and Door Mirror system	<ul style="list-style-type: none"> <li>- Identify and locate Power window and door mirror system components</li> <li>- Able to troubleshoot Power Window System</li> </ul>
2.	Repair Wiper, washer and Defogger system	<ul style="list-style-type: none"> <li>- Identify and locate Wiper , washer and Defogger System components</li> <li>- Able to troubleshoot Wiper, washer and defogger System</li> </ul> <p><b>Windshield wiper and water spray pump</b></p> <ul style="list-style-type: none"> <li>- Check/ Change wiper fuse</li> <li>- Check/ repair wiper motor</li> <li>- Check/ repair wiper control switch</li> <li>- Check/ repair wiring or ground and power supply</li> </ul>

		<ul style="list-style-type: none"> <li>- Check/ replace water spray motor</li> <li>- Check/ repair washer hose or nozzle</li> </ul>
3.	Repair Lighting Systems	<ul style="list-style-type: none"> <li>- Identify and locate lighting system components</li> <li>- Able to repair Lighting system</li> <li>- Disconnect the negative battery terminal.</li> <li>- Determine the wiring circuit as per manufacturer.</li> <li>- Locate the blown/fused bulbs/lamps of the lightening system.</li> <li>- Disconnect the electrical connectors after marking them with tape for identification when reinstalling.</li> <li>- Remove components as necessary to gain access to the blown bulbs/lamps/fuses as per manufacturer's procedure.</li> <li>- Clean bulb holder and wiring harness.</li> <li>- Remove the bulb/lights/lenses assembly.</li> <li>- Check short circuit, loose connection or poor ground in the wiring.</li> <li>- Replace new bulbs/lights as specified watt.</li> <li>- Replace bulb cover, lenses assembly.</li> <li>- Replace components that were removed to gain access the bulbs/ lights.</li> <li>- Connect battery negative terminal.</li> <li>- Switch on the switches to check the bulbs.</li> <li>- Set Headlight Beam</li> <li>- Adjust air pressure of all tyres as per the manufacturers' recommendation</li> <li>- Move vehicle up and down by hand to settle its attitude</li> <li>- Move it over a flat surface</li> <li>- Set vertical beam alignment by means of the screw provided in head light</li> <li>- Set the head light in such a way that the main beam axis falls on a spot not above the height of head light and not below a height equal to a fifth (1/5) of the head light height.</li> <li>- Set horizontal beam alignment by using screw provided in head light</li> </ul>
4.	Repair Immobilizer and Push button start (Smart Key) system	<ul style="list-style-type: none"> <li>- Identify and locate immobilizer and push button start system components.</li> <li>- Able to repair locate immobilizer and push button start system</li> </ul>
5.	Change Relays and fuses in electrical system	<ul style="list-style-type: none"> <li>- Disconnect battery negative terminal.</li> <li>- Note down carefully the positions in which the various components are fitted in order to ensure the correct replacement on reassembly.</li> <li>- Consult the service manual or wiring diagram to locate the relay or switch that you want to replace.</li> <li>- Remove cover or other components to gain access to</li> </ul>

		<p>the relay or switch</p> <ul style="list-style-type: none"> <li>- Remove the faulty relay or switch.</li> <li>- Check the relay or switch for continuity, voltage or resistance as per service manual.</li> <li>- Trace out the fault or defective relay or switch.</li> <li>- Replace new relay or switch with correct rating or specifications.</li> <li>- Connect battery terminal.</li> <li>- Check the operation of the relay/switch.</li> </ul>
6.	Repair Power door lock and Central door lock System	<ul style="list-style-type: none"> <li>- Repair Power door lock and Central door lock System</li> </ul>

### **G. Restrain System (Airbag System)**

<b>S. N.</b>	<b>Assignments</b>	<b>Skills</b>
1	Diagnoses restraint systems	<ul style="list-style-type: none"> <li>- identify type of restraint systems</li> <li>- identify restraint system components</li> <li>- inspect restraint system components</li> <li>- inspect restraint system monitoring and warning system</li> <li>- identify restraint system DTCs</li> <li>- perform tests using scanner and multimeter as per manufacturer's guideline</li> <li>- record, interpret and analyze results of tests and inspection</li> </ul>

# Automobile Body Shop Repair

(8 Weeks – 320 hours)

<b>Unit 1: Understanding elements involved with auto body repair and paint</b>	<b>(Total - 8 hrs)</b>
1.1 Discuss and analyze necessity of collision repair	2 hrs
1.2 Discuss a body shop layout and its designing.	2 hrs
1.3 Discuss the function of auto body personnel and body shop	2 hrs
1.4 Find the variables necessary to write an accurate collision damage estimate	2 hrs
<b>Unit 2: Paint and body shop safety (BASIC FIRST AID)</b>	<b>(Total- 10 hrs)</b>
2.1 Observe the basic personal safety equipment (Respiration, safety glasses, and welding helmet, etc.)	2 hrs
2.2 Observe proper dress in body shop (boots, no loose clothing or jewelry, tie hair, etc.)	
2.3 Discuss and observe all shop safety rules	
2.4 Demonstrate basic first aid	2 hrs
2.5 Paint safety training (Online)	2 hrs
2.6 Shop safety training (Online)	2 hrs
2.7 Discuss and observe environmental pollution prevention	2 hrs
<b>Unit 3: General hand tools (USE &amp; IDENTIFICATION)</b>	<b>(Total- 4 hrs)</b>
3.1 Demonstration of use of various hand tools	2 hrs
3.2 Demonstrate safe use of hand tools	2 hrs
<b>Unit 4: Power tools (USE &amp; IDENTIFICATION)</b>	<b>(Total- 4 hrs)</b>
4.1 Demonstrate use of various power tools	2 hrs
4.2 Demonstrate safe use of power tools	2 hrs
<b>Unit 5: Introduction to welding and cutting</b>	<b>(Total- 30 hrs)</b>
5.1 Use of MIG welder in dent operation, Oxy Acetylene Gas welding process, Gas cutting, Dent puller and discuss types of welds	30 hrs
<b>Unit 6: Metal working</b>	<b>(Total- 26 hrs)</b>
6.1. Practical in metal straightening techniques	
a. Rough out	6 hrs
b. Kinking	6 hrs
c. Cold shrinking	6 hrs
d. Heat shrinking	4 hrs
e. Finishing	4 hrs
f. Identify when panel should be repaired or replaced	
<b>Unit 7: Body fillers (PLASTIC &amp; FIBERGLASS FILLERS)</b>	<b>(Total- 5 hrs)</b>
7.1 Demonstrate use and application	3 hrs
7.2 Determine when to use waterproof fillers	2 hrs

<b>Unit 8: Surface preparation</b>	<b>(Total- 32 hrs)</b>
8.1 Evaluate grit-rating chart	8 hrs
8.2 Determine method of preparation for specific substrate	8 hrs
8.3 Demonstrate metal conditioners and adhesion promoters	8 hrs
8.4 Demonstrate and discuss solvent cleaners	8 hrs
<b>Unit 9: Masking for Custom Painting</b>	<b>(Total- 18 hrs)</b>
9.1 Identify and demonstrate types of masking tapes and proper use (fine line, dart, etc.)	6 hrs
9.2 Identify and demonstrate types of masking paper and plastic sheeting	6 hrs
9.3 Discuss and demonstrate masking techniques (back & reverse masking)	6 hrs
<b>Unit 10: Math and Measuring Sketching a design</b>	<b>(Total- 9 hrs)</b>
10.1 Demonstrate how to use a tape measure	3 hrs
10.2 Determine how ratios, percentages and fractions relate to auto body repair	3 hrs
10.3 Basic math review and exercises	3 hrs
<b>Unit 11: Mixing and applying undercoats</b>	<b>(Total- 40 hrs)</b>
11.1 Identify and handle undercoats	10 hrs
11.2 Determine proper undercoat for specific substrate	10 hrs
11.3 Demonstrate mixing and application technique for undercoats	10 hrs
11.4 Demonstrate how the substrate determines type of undercoat to be used	10 hrs
<b>Unit 12: Mixing and applying topcoats</b>	<b>(Total- 30 hrs)</b>
12.1 Discuss purpose and characteristics of topcoats	10 hrs
12.2 Examine types of topcoats (single stage, basecoat, clear coat and multi-stage)	10 hrs
12.3 Demonstrate mixing and application and topcoats	10 hrs
<b>Unit 13: Refinishing equipment</b>	<b>(Total- 24 hrs)</b>
13.1 Examine types of spray equipment (gravity, suction and pressure feed)	12 hrs
13.2 Identify spray gun components and demonstrate spray techniques	12 hrs
<b>Unit 14: Auto construction</b>	<b>(Total- 30 hrs)</b>
14.1 Demonstrate types of materials used in vehicle construction	10 hrs
14.2 Examine vehicle construction (body-over-frame, unibody, space frame)	10 hrs
14.3 Identify auto body parts. Proper nomenclature	10 hrs
<b>Unit 15: Fasteners</b>	<b>(Total- 20 hrs)</b>
15.1 Demonstrate fastening to hold a vehicle together	8 hrs
15.2 Determine types of fasteners used in vehicle construction (nuts, bolts, screws, etc.)	6 hrs
15.3 Review of terminology (bolt strengths or grades)	6 hrs

<b>Unit 16: Automotive detailing</b>	<b>(Total- 24 hrs)</b>
16.1 Demonstrate the importance of auto detailing	6 hrs
16.2 Identify methods to clean paint surfaces	6 hrs
16.3. Identify methods to clean glass	6 hrs
16.4 Identify methods to clean interior, carpet, upholstery, etc.	6 hrs
<b>Unit 17: Internet Research for Collision Repair</b>	<b>(Total- 32 hrs)</b>
17.1 Review Dealer sites	8 hrs
17.2 Review Insurance sites	8 hrs
17.3 Review Parts Search	8 hrs
17.4 Review and Identify and use Refinish Material web sites	4 hrs
17.5 Review repair techniques at autobody.com	4 hrs

## Curriculum Development Expert Team

<b>SN</b>	<b>Name</b>	<b>Designation</b>	<b>Name of Office</b>
1	Dr. Krishna Prasad Shrestha	Asst. Professor	Kathmandu University
2	Ram Prasad Bhatta	Instructor	Sipradi Trading Pvt.Ltd
3	Dipesh Poudel	Training Manager	Sipradi Trading Pvt.Ltd
4	Basuden Timalina	Training Manager	Laxmi Intercontinental, (Hyundai)
5	Gautam Manandhar	Co-Tech	Renault (Advanced Automobile)
6	Raj Kumar Chaulagain	Lecturer	Thapathali Campus
7	Prem Lal Tamang	Service Manager	Laxmi Intercontinental, (Hyundai)
8	Sanny Pradhan	Instructor	Thapathali Campus
9	Alok Kumar Chaudhary	Mechanical Engineer	Ministry of Defense
10	Dr. Surya Prasad Adhikari	Asst. Professor	Thapathali Campus
11	Subash Kumar Ghimire	Lecturer	Thapathali Campus
12	Laxman Palikhel	Asst. Instructor	Thapathali Campus
13	Mahesh Kumar Sah	Training Manager	C.G. Motor Corporation