TRACTOR SYSTEMS AND CONTROL

ENAE 252

Lecture : 3 **Year : II**
Tutorial : 1 **Part : II**
Practical : 2

Course Objectives:
The main objective of this course is to introduce fundamental concepts, principles, and components of farm tractors and control systems, along with their applications. It also emphasizes the significance of ergonomic science, its principles, and their role in tractor design. Additionally, the course aims to equip students with the knowledge to analyze and optimize tractor applications for cost-effective field operations.

1 Tractor as Source of Mechanical Farm Power (2 hours)

1.1 History of development of tractors
1.2 Classification of tractors
1.3 Essential features of farm tractors
1.4 Ranges and availability in the country
1.5 Tractor selection criteria

2 Systems and Controls in Farm Tractors (20 hours)

2.1 Types of power transmission
  2.1.1 Two and four wheeled drive
  2.1.2 Hydrostatic and hydrodynamic drives
  2.1.3 Design principles for power transmission
2.2 Clutch System
  2.2.1 Purpose and types
  2.2.2 Principle of operation
  2.2.3 Functional requirements
  2.2.4 Design parameters and procedure
2.3 Gear Box
  2.3.1 Purpose and types
  2.3.2 Principle of operation
  2.3.3 Functional requirements
  2.3.4 Design parameters and procedure
2.4 Differential and final drive
  2.4.1 Purpose and types
  2.4.2 Principle of operation
  2.4.3 Functional requirements

2.5 Steering System
- 2.5.1 Purpose and types
- 2.5.2 Principle of operation
- 2.5.3 Components involved in mechanical steering
- 2.5.4 Functional requirements
- 2.5.5 Adjustments: Camber, caster, toe-in, toe-out, kingpin inclination, tie-rod locking

2.6 Brake System
- 2.6.1 Purpose and types
- 2.6.2 Principle of operation
- 2.6.3 Functional requirements
- 2.6.4 Design parameters and procedures

2.7 Hydraulic System
- 2.7.1 Purpose and types
- 2.7.2 Hydraulic circuit symbols
- 2.7.3 Principle of operation
- 2.7.4 Functional requirements
- 2.7.5 Automatic position and draft controls

2.8 Auxiliary power transmission and power outlets
- 2.8.1 Power takes off (PTO) system, its functions and types
- 2.8.2 Belt, pulley and drawbar: Functional requirements and design parameters
- 2.8.3 Special power drives for front and side mounted implements

3 Traction and Traction Theory (4 hours)

3.1 Mechanics of a rigid wheel (Traction and towed)
3.2 Construction of tractor tyre
3.3 Inflation pressure
3.4 Theoretical soil thrust on traction device
3.5 Rolling resistance and travel reduction
3.6 Coefficient of traction and tractive efficiency
3.7 Tractive effort, rim pull, drawbar pull
3.8 Traction parameters and design of traction device
3.9 Traction aids and wheel ballasting: Types and selection criteria
3.10 Soil compaction in tillage and traction

4 Mechanics of Tractor Chassis (4 hours)

4.1 Static and dynamic forces acting on tractor chassis
4.2 Location of center of gravity and moment of inertia
4.3 Static equilibrium analysis
4.4 Analysis for maximum achievable drawbar pull
4.5 Longitudinal stability and stability at turns

5 Tractor Hitching (3 hours)

5.1 Terminology used in tractor hitching
5.2 Types: single axis hitching, two-axes hitching, automatic hitching
5.3 Weight transfer and stability
5.4 Break-away principle and other safety devices

6 Power Tiller and Mini Tiller (4 hours)

6.1 Purpose and types
6.2 Range and availability
6.3 Control systems of power tillers

7 Ergonomic Principles in Tractor Design (3 hours)

7.1 Human factors in tractor design
7.2 Human tolerance to temperature, noise and vibration
7.3 Importance of ergonomic principle in tractor seat design, Controls and Control Panel

8 Tractor Testing (3 hours)

8.1 Purpose of testing
8.2 Tractor test codes
8.3 Engine and drawbar performance at full and part load
8.4 Performance data of major makes and models of tractors used in Nepal

9 Economics of Tractor Use (2 hours)

Tutorial (15 hours)

1. Clutch
2. Gear Box
3. Brake System
4. Traction and Traction Theory
5. Mechanics of Tractor Chassis
6. Economics of Tractor

Practical (30 hours)

1. Dissembling and assembling of clutch system, components involved and maintenance operation
2. Dissembling and assembling of gear box, components involved and maintenance operation
3. Dissembling and assembling of differential and final drive, components involved and maintenance operation
4. Study on steering system: Components involved and adjustments of camber, caster, toe-in and toe-out

5. Dissembling and assembling of brake system, components involved and maintenance operation
6. Dissembling and assembling of hydraulic system, components involved and maintenance operation
7. Study on wheel parameters and ballasting in farm tractors
8. Hitching of mounted, semi-mounted and trailed type farm implements and stability analysis
9. Study on control systems of power tillers and mini tillers

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapters	Hours	Marks distribution*
1 and 2	22	32
3,4 and 5	11	12
6 and 7	7	8
8 and 9	5	8
Total	**45**	**60**

* There may be minor deviation in marks distribution.

Reference

1. Bureau of Indian Standards. (1998). Test codes for agricultural implements, I.C. engines, and tractors. New Delhi, India: Bureau of Indian Standards.
2. Frazee, I., Philip, V. E. (1974). Tractors and crawlers. Prentice Hall.
3. Gill, W. R., Vanden Berg, G. E. (1968). Soil dynamics in tillage and traction (U.S. Department of Agriculture Handbook No. 316). U.S. Government Printing Office.
4. Goering, C. E., Hansen, A. C. (2004). Engine and tractor power (4th ed.). ASABE.
5. Kolchin, A., Demidov, V. (1984). Design of automotive engines. MIR Publishers.
6. Liljedahl, J. B., Carleton, W. M., Turnquist, P. K., Smith, D. W. (1979). Tractors and their power units. John Wiley & Sons.
7. Pinches, M. J., Ashby, J. G. (1989). Power hydraulics. Prentice Hall International (U.K.) Ltd.