SUGGESTED CURRICULUM FOR AG. ENGINEERING IN PAKISTAN

A Report on Special Problem of A. E. 811
In Partial Fulfillment for the Degree of M. S.
MICHIGAN STATE UNIVERSITY

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Suggested Curriculum for Ag. Engineering in Pakistan

by

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Submitted to
Michigan State University
in partial fulfullment of the requirements
for the degree of
MASTER OF SCIENCE

Department of Agricultural Engineering

ABSTRACT

The primary objective of this paper was to propose a curriculum for a B.S. Degree in Agricultural Engineering in Pakistan. The introduction also explains the reason why Agricultural Engineering is needed in Pakistan. The work of writing has been carried out by the following manners:

1. Consulting different curriculums of various universities.

2. Consulting different Text Books.

3. By discussion with some Professors at M.S.U. in the concerned field.

The curriculum shows first the courses which for the first two years are studied by every engineering student together and these courses exist presently in the Engineering Colleges. After this, it shows the suggested courses in Agricultural Engineering which will be taught exclusively by the Department of Agricultural Engineering. These courses have been explained in detail in their Theory and Lab work.

Approved _____

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INTRODUCTION

The physical basis for the economic development of the country is found in its land, water, mineral resources, its productive capacity in food and raw materials and in the factors of climate and terrain which condition their use. These resources are wide in variety and the environmental factors present great contrast.

1. The Land area of Pakistan is a little over 230 million acres. About 85 percent of the total area lies in West Pakistan but a quarter of its land is classified as unavailable for cultivation because of water logging and salinity and some climatic factors where irrigation is not available. Less than one seventh of East Pakistan's area is also classified as unavailable of cultivation because of floods. Slightly less than four percent of the country is forest and of this area more than half is in East Pakistan.

2. Terrain. East Pakistan is a flat deltic plain laced by a dense network of water courses with shifting and unstable beds. Annual floods of varying intensities are a normal feature of about 1/3 of the cultivated area. Average yearly rain fall of 76 inches is unevenly distributed. About five-sixth of this torrential rain fall comes during four or five monsoon months.

In West Pakistan the annual rain fall varies from 30 to 40 inches in the Northern tracts and dwindles to 5 inches in the Southern plains. Extensive upland desert and mountain areas are barren with wide ranges in temperature, low humidity and strong winds.

3. Productivity. In east Pakistan the pressure of population on the land is severe and little additional acreage is avialable for cultivation. Hence, the key problem in East Pakistan is "How to increase Productivity".

In West Pakistan there are still large areas to be brought under cultivation through extended irrigation facilities and mechanized farming. Alternating floods and drought; and salinity from sea water are the problems in East Pakistan. Water-logging and salinity threaten the soil in many areas of West Pakistan. Erosion also takes a heavy toll in West Pakistan. Principal crops of East Pakistan are rice, jute, tea and sugar cane and those of West Pakistan are wheat, cotton, rice and sugar cane. For a country which is in the development state, these sources need to be developed efficiently. To get maximum economical production modern means of automated mechanical production may be employed. To employ this modern means, people with the "know how" and technically skilled are required. For producing such skilled people we need to set up Ag. Engineering Departments in various universities.

Our government is realizing the importance of this branch of Science and the need for improved practices. In the following lines, I will quote a paragraph from our "SECOND FIVE YEAR PLAN" which emphasizes on Agricultural Science and Ag. Engineering for maximum economical production.

> The key inputs of production which are water, improved seeds, improved implements, fertilizers and plant protection, will have to be provided in suitable quantities and at the right time. However, simpler and low-cost cultural practices deserve recognition in a program of this type. Through land preparation, mulching, line sowing, weeding and other labor-intensive practices of known value should be encouraged. In this process an extraordinary burden will be placed on the technical and information services. Each village in the selected districts should have at least one demonstration plot with sufficient variety of practices to show what is practicable and what is not.

Along with the above mentioned practices, simpler and lower cost practices cannot be ignored because all of the land is not in big tracts to practice large machine operations on the whole of the crop producing land. Still in the near future there will be enough land to be operated by machinery economically. Primary objectives of the three five year plans is to make the country self-sufficient in food grains and to improve the dietry standards and standards of living. To improve the standard of living requires low prices of different food items processed by the food industry and making a sufficient supply of it. This requires the development of land which is not yet under cultivation and which is very difficult to accomplish on a large scale without the use of agriculture machinery. This also involves the development of the existing irrigation system and exploring new irrigation canals for the new developing land. The rainfall is not sufficient for the existing crops in West Pakistan and therefore it requires efficient irrigation system.

After independence in 1947 uptil now our country did not think seriously to develop this branch of Science although the Science of Agriculture has been promoted by establishing Agricultural Universities and Colleges. But now it is being realized that Ag. Engineering is also an important branch of Engineering and plays a very important role in the development of a country.

The student who gets a B.S. Degree in Agricultural Engineering can work in the following areas:

1. Extension Service. The extension service is needed by the people working on the farm because they know very little about mechanized farming. They are doubtful about the economical use of farm machinery in the first place and, therefore, they need someone to tell them about the working and benefits derived from the farm machinery. Our government is now beginning to set up Farm Machinery Work Shops in each district. Agricultural Engineers will be required in each of the district work shops. District agricultural engineers can do the job of extension service by giving information to the man on the farm and demonstrating practically the working of farm equipment.

2. Food Industry. In the near future we will need Agricultural Engineers working in food industry. Even at present there are lots of

opportunities for Agricultural Engineers in the fruit and vegetable canning industry and dairy industry.

3. Farm Machinery Design and Production Industry. In the very near future, we are starting to build small farm tractors and other equipment which can be used by small land owners. Our government will help the small land owner to buy these equipments in the form of Government Subsidies. Agricultural Engineers will be needed in the area of design and production and also in the area of teaching this side of Ag. Engineering.

4. Government Department of Agriculture. An Agricultural Engineer will find a job in this department working in the area of soil, water, irrigation and as a maintenance engineer.

In this humble effort of mine, I will try to set up a curriculum for the B.S. Degree in Agricultural Engineering for a four year course, I will try to cover all the four important areas of Agricultural Engineering mentioned above in which an Agricultural Engineer can work.

The curriculum should meet the following requirements:

1. It should be for Agricultural Engineering undergraduate courses in an Engineering College.

2. It should be such that can be taught by the joint efforts of Eng. College and Agricultural College.

3. It should be flexible so as to meet the demand of Agriculture on the farm in the various fields of Agricultural Engineering.

4. The curriculum should also meet the demand of the food industry in the area of heat transfer which will need Ag. Engineers in the future.

5. The curriculum should also meet the demand in Crop Processing and Storage, of which there is shortage in our country and much of the crops are wasted due to lack of storage facilities.

6. The curriculum should also be able to give adequate understanding of the machinery used in agriculture.

7. The curriculum should be sound and dependable so as to fulfill the need as the other curriculums of other branches of Eng.

8. Meet the needs of people presently engaged in the agriculture industry.

CURRICULUM

The set up of our universities is such that we have a session of nine months. The session starts from September 1 and ends on June 15 each year. There is only one final exam in May and those who could not

appear in the exam of May due to some reason, they are given a chance to appear in September. The curriculum of first and second year engineering is the same and for these two years all engineering students take the same courses. In the third year of engineering some of the courses are separate and in the fourth year all the branches of engineering have almost separate courses.

Classes meet six days a week and the session starts from September 15 up to April 15. Average number of weeks for the whole session is 25.

Students' background of education consists of ten years of schooling in primary and secondary high school. After ten years schooling, two years of college is compulsory with physics, mathematics, English and chemistry before joining Engineering College. Selection of students is done on merit basis.

The course work in this report has been divided into four parts for the 1st year, 2nd year, 3rd year and 4th year, respectively. Each part is preceded by a table which shows the subject to be taught, time and points allocated to each subject. The details of each table content is being given in the pages followed.

Mathematics; E. (101)

Complex numbers and their graphical representation; relation between exponential, trignometric, hyperbolic and logrithmic functions. Application of derivative; tangents and normals. Polar co-ordinates; simple polar curves; parametric curves; Maclaurins and Taylors series. Maxima and minima; integration; definite integrals; centroids and moment of inertia of pnane areas and of simple solids.

Applied Mechanics; E. (102)

Statics; forces acting at a point; parallel forces; properties of couples; simple structures; simple stresses and strains; strength of bean; bending moments and shearing forces.

Dynamics; work, energy and power; friction; velocity and acceleration; inertia; angular momentum; fly wheel; transmission of motion by belt, rope, chain and toothed wheels.

Physics; E. (103)

General physics; heat; sound; light.

Magnetism and electricity; magnetism; electrostatics; current electricity; electronics.

Chemistry; E. (104)

Water and metallic corrosion; fuels and combustion; lubricants; chemistry of iron; paints and varnishes; organic plastics; cement and refractories; glass; atomic structure and radio activity.

Geometrical Drawings; E. (105)

Projection of points, lines and solids in simple positions; first and third angle projections; projection of curves and curved surfaces; sections of solids; tangent planes of surfaces and interpenetration of solids; development of surfaces; isometric and pictorial projections of solid figures.

Engineering Drawing; E. (106)

Planning a drawing; representation of rivets, riveted joints, screw fastenings and screw systems, keys, cotters and pulleys; assembly drawings of the objects selected from; bearings, wall brackets, pipes and pipe fittings, shaft couplings, pistons, cylinders, piston rods, connecting rods, valves, accentrics, stuffing boxes.

Work Shop Practice; M.E. (131)

Materials in engineering production, reading a machine drawing; pattern making; bench work; Smith's work; elementary machine shop.

Surveying; C.E. (111)

Chain surveying; compass surveying; plane table surveying; theodolite traversing; leveling and controlling; surveying computations.

English (Humanities); E. (109)

Importance of written and spoken works; the organization of material and the logical presentation of facts and opinion in speech and writing; preparation of short speeches and the conduct of debates; the common mistakes and difficulties encountered by the students in expressing himself in a language not his mother tongue.

Curriculum - Second Year Engineering

Total Number of Weeks/Session = 25

	Subject	Hours/Week			Marks			
		Theory	Practical	Total	Theory	Practical	Sessional	Total
E. (201)	Mathematics	2		2	150		50	200
C.E. (211)	Theory of Structures and Strength of Materials	2	2	4	100	50	50	200
C.E. (212)	Fluid Mechanics	2	2	4	100	50	50	200
E. (202)	Engg Drawing	4		4	100	25	25	150
M.E. (231)	Heat Engines and Elements of Thermodynamics	2	2	4	100	50	50	200
M.E. (232)	Mechanism and Theory of Machine	2		2	100		50	150
E.E. (221)	Electrical Technology	2	2	4	100	50	50	200
M.E. (233)	Work Shop Practice, II	2	2	4	100	50	50	200
E. (203)	Humanities	1		1	75		25	100

Total Weekly Load = 29 hours

Mathematics; E. (201)

Determinants; areas of surfaces and volumes of solids of revolution and their centroids; double and triple integrals; fourier series, and harmonic analysis; laws of graphs and methods of least square as applied to determination of unknowns; common and parabolic catenary; differential equations; second order differential equation; standard form, and special forms; definition and proof of the theorem of virtual work.

Strength of Materials and Theory of Structures; C.E. (211)

Strength of materials; stresses and strains; nature and properties of engineering materials, stresses and strains in cylinders and pipes; bending moments and shearing force diagrams for simple cases of cantilevers and simply supported beams; bending theory and assumptions; derivation of flexure formula; bending stress and section modulus; deflection of beams; development of Torsion formula for circular shafts, solid and hollow.

Theory of structure; rolling loads; single concentrated load, uniformly distributed loads longer than span and shorter than span. Two concentrated loads travelling at a fixed distance apart; several point load; influence lines for a series of travelling loads at fixed distance apart; influence lines for reactions and for girders with floor beams. Framed structure and mass structures redundancy and analysis of forces in determinate fromes; axial loading of columns; Euler's formula for long columns; Rankine's formula; Johnson's parabolic formula.

Fluid Mechanics; C.E. (212)

Static Pressure due to liquids; hydro-static force on areas; gauges; stability of floating bodies, gravity dams; laminar and turbulent flow of water; Bernoullis equation: forced vortex; dynamic similarity and models; measurements of flow of water by Pitot tube, orifice, nozzels; venturimeters, weirs, fluid friction through pipes; Froude's number; hydraulic gradient; loss of head due to friction; Reynold's experiments on flow through pipes; fluid viscosity; boundary flow through tubes.

Engg Drawing; E. (202)

Drawings and assemblies of valves, engine and machine parts, boiler fittings; locomotive and internal combustion engine details; practice drawings of miscellaneous equipment as screw jack, vice, friction clutch and force pump. Selected exercises from building and plant layout, structural joints and architectural drafting without design calculations.

Heat Engines and Elements of Thermodynamics; M.E. (231)

Theory applied to I.C. Engines; pressure, volume and temperature measurement; laws of thermodynamics; gas equation; work done under different methods of expansion of gases; air, otto, diesal and dual combustion cycles, I.C. engine classification. Steam Boilers and boiler auxiliaries; properties of steam; use of steam tables; p.v. diagrams; introduction to entrapy; performance curves of steam engines; history and development of steam turbine, impulse and reaction turbine; use of compressed air and types of air compressors. Single stage, multistage reciprocating compressors. Introduction to air conditioning and

refrigeration.

Mechanism and Theory of Machine; M.E. (232)

Velocity and acceleration diagrams; slider chain mechanism; angular acceleration of a link; types and characteristics of cams; cam shapes to give a required motion with and without roller follower; simple and compound gear trains; properties of involute and cycloidal teeth; balancing of rotating masses in one plane, in parallel planes; torsional vibrations of simple uniform and stepped shafts with a single inertia system; friction of pivots, collars, thrust bearings, plate and cone clutch. Transmission of energy by belts, ropes, chains and screw threads. Centrifugal and inertia governors.

Electrical Technology; E.E. (221)

Fundamentals of electrical concepts and units; conductors and insulators; laws of electrical circuits and their application to series, parallel and series parallel circuits; electromagnetic induction and electromotive force. A.C. Circuits; voltage and current equations, effective and average values; vector representation of voltages and currents; sinosidal voltage applied to R, L and C circuits; electrical measurements; operating principle of moving coil indicating instrument; measurement of resistance by ammeter-voltmeter method; wheat stone bridge; properties of common types of conducting, insulating and magnetic materials. D.C. Machines; principle and construction; E.M.F., speed and torque equations; machine losses and efficiency; D.C. motor starter. Principle, construction, E.M.F. equation of an alternator. Principle, construction, E.M.F. equation, current and voltage ratio, no load vector diagrams, efficiency and losses of a single phase transformer. Principal, construction of an induction motor; cage and slip ring rotors; slip and efficiency calculations. Construction of lead acid and alkaline batteries; method of charging, common fault and remedies.

Work Shop Practice II; M.E. (233)

Description of various machine tools, lathes, drilling machine, grinding, shaping and milling machine; description of various tool fixtures and appliances; simple pattern formation of sheet metal, bending, seaming, soldering and brazing; electric and gas welding apparatus. Use and description of foundry furnaces such as cupola, ordinary furnace or crucible for ferrous and non-ferrous metal, oil fired tilting furnace; classification of sands; bonding properties of sand; preparation of sands for foundry work; preparation of moulds and melting materials; use and description of electrician tools; classification of house wiring, power wiring; testing of house wiring.

Humanities; E. (203)

Development of science and technology; Greek Science; Greek and Roman engineering and technology; the rise of Astrology and Alchemy; Muslim contribution to medieval advancement of maths, astronomy, physics, chemistry and optics; medieval technology and engineering; Isaac Newton and the impact of his findings in physics and other fields; heat and steam engine; astronomy in 19th century; impact of steel and electricity on the world; physics in the 20th century; Einstein; development of technology during and post World War II; radio, radar and radio astronomy.

Curriculum - Third Year Ag. Engineering

Total Number of Weeks/Session = 25

	Subject	Hours/Week			Marks			
		Theory	Practical	Total Per Week	Theory	Practical	Sessional	Total
C.E. (311)	Hydraulics and Hydraulic Machinery	2	2	4	100	50	50	200
C.E. (312)	Advanced Strength of Materials and Theory of Structure	2	2	4	100	50	50	200
E. (302)	Engg Geology	2		2	100		50	150
A.E. (341)	Basics of Agr. Machinery and Agr. Power	2	2	4	100	50	50	200
AGR (351)	Soil and Water Conservation and Crop Production	2		2	100		50	150
A.E. (342)	Farm Irrigation	1	2	3	100	50	50	200
A.E. (343)	Functional Planning of Farm Structures and Material of Construction	2	2	4	100	50	50	200
A.E. (344)	Farm Processing and Different Modes of Heat Transfer	2	2	4	100	50	50	200
E. (303)	Engg Economics	1		1	100			100

Total Weekly Load = 28 hours/week

Hydraulics and Hydraulic Machinery; C.E. (311)

Uniform flow in open channels; Chezy's and Manning's formula; critical depths of flow in rectangular and non-rectangular channels; non-uniform flow in open channels, energy equation; surface of curvature in varied flow; hydraulic jump. Discharge with varying heads in unsteady flow; velocity of pressure waves; valve opening and closing; water hammer; laminar boundary layer; friction dray of laminar boundary layer; friction in turbuletn boundary layer; friction drag in transition region, boundary layer separation; pressure drag on two and three dimensional bodies; lift and drag diagrams; theory of propeller propulsion. Compressible Fluids; basic gas laws; types of flow; application of continuity; energy and momentum equations; flow of gases through nozzles, pipes and ducts; impulse and momentum; dynamic force on stationary body and a body in translation; reaction of jet and jet propulsion; reciprocating and centrifugal pumps; reaction and impulse turbines; brief description of tube well and air lift pumps.

Advanced Strength of Materials and Theory of Structure; C.E. (312)

Compound Stresses and Strains; principle planes and principle stresses in a general two dimensional system; general two dimensional strains; Mohr's circle for compound stresses and strains; theories of failure under compound stresses and their application to combined direct, bending and shear stresses. Stresses and Deflection in Beams and Shafts; harder cases of bending moment and shear force diagrams; unsymmetrical bending, deflection of beams and shafts under load; application of area moment; conjugate beam and step function beams, curved beams; principals of reinforced concrete beam design, slabs, columns and foundations; elementry idea of concrete mix design; properties, uses and testing of materials of construction; standard specification of metals and non-metals; introduction to the study of experimental stress analysis.

Earth Pressure; Rankines and Columbs' wedge theory; earth pressure on retaining wall with or without surcharge; stability of walls and masonary dams; Analytical and graphical methods of finding deflections for pin-joined frames; castigliano's theorems; Clark-Maxwell's reciprocal theorem. Frames with one or two redundancies; the trussed beam; light suspension bridges anchor cables; three hinged stiffening girders. Analysis of three-hinged arches of segmental and parabolic shape for B.M.; S.F. and Thurst; influence lines; temperature effects.

Engineering Geology; E. (302)

Physical Geology; origin and composition of the earth's crust; study of rocks and rock forming minerals; rock weathering and formation of soils; igneous intrusive action; volcanic action; geological structures; rock folding, faulting and joining; significance of bedding; the work of erosion by water, ice, wind and sea. The stratified sedimentary rocks and their distribution; the occurrence and use of fossils; stratigraphy of Pakistan. Construction and use of geological maps and sections;

Applied Geology; outline of geology of coal, petroleum, and natural gas; soils, soil sampling and soil mechanics; clays, brick making, portland and other cements; foundation investigations; influence of ground water on foundation design; landslides; dam sites; tunnels and currings in variable strata geological conditions in road and railway construction;

canals, harbors and coastal protections; applications of geology in earth quake districts and regions subject to permanently frozen ground.

Basics of Agr. Machinery and Agr. Power: A.E. (341)

Explained Later in Detail.

Soil and Water Conservation and Crop Production; AGR. (351)

Soils; soil genesis; physical properties of mineral soils, soil colloids; soil air; soil water; soil reaction.

Soil Conservation; modern concept of soil conservation; climate and erosion; rain fall penetration; flood control; erosion problem of Pakistan.

Control Measures; proper land use; crop rotation and crop fallow; stubble mulch farming; contouring; terracing; gully control; vegetated outlets and water courses. Embankments and reservoirs; farm drainage; crop production of wheat, rice, corn, sugar cane, cotton, tobacco.

Farm Irrigation; A.E. (342)

Explained Later in Detail.

Functional Planning of Farm Structures and Material of Construction; A.E. (343)

Explained Later in Detail.

Farm Processing, Different Modes of Heat Transfer and Their Use in Farm Processing; A.E. (344)

Explained Later in Detail.

Introduction to Engg Economics; E. (303)

Basic Concepts; micro and macro economics; static and dynamics.

Demand and Supply Analysis; price; the market; demand; consumer's demand; indifference curve analysis; equilibrium of the firm; competitive industry; competitive equilibrium; monoply; laws of return; the pricing factors of production. Money and banking; international trade and balance of payments; public finance.

Hydraulic Structural Design; C.E. (411)

Design and Construction details of earth dams; design and construction details of low and high gravity dams including the design of spillways. Design of sluices, weirs and irrigation channel; design of irrigation channels including transitions. Design of acqueducts, super passage, and syphon.

Soil Physics and Drainage; A.E. (441)

Explained Later in Detail.

Hydrology; C.E. (412)

The atmosphere, its temperature, pressure and circulation. Precipitation; evaporation; run off and stream flow; flood routing; application of statistical analysis to hydrology.

Advanced Study of Agr. Machinery and Agr. Power; A.E. (442)

Explained Later in Detail.

Water Supply and Sanitiation; C.E. (413)

Estimation of water requirements and supply; general procedure in water works design; distribution of water; pumps; filtrations; disinfection; sanitary engineering; principal of sewage disposal.

Rural Electrification; A.E. (443)

Explained Later in Detail.

Reinforced Concrete; C.E. (414)

Properties of concrete; beams and slabs; shear reinforcement; flanged beams; columns; concern footing; combined bending and direct stress; typical R.C.C. structures; prestressed concrete.

Humanities; E. (401)

Engineer and his education; success in the engineer profession; the engineer at work; personal and ethical relations.

Project and Thesis; A.E. (444)

Explained Later in Detail.

OUTLINE OF A.E. COURSES IN DETAIL

Basics of Agr. Machinery and Agr. Power A.E. 341

Prerequisite - M.E. 231

Text Used - Principal of Farm Machinery by Bainer, Kepner and Barger
Farm Gas Engines and Tractors by Jones

Reference - Equipment for Rice Production prepared by B. A. Stout under F.A.O.

Sample Quiz is for the evaluation of sessional marks and may take place each month or each after two months.

OUTLINE OF THE THEORY COURSE

Part (A)

Machine Elements. The language of machinery: elements of mechanical principles; materials of machine construction; heat treated material.

Principles of Power Transmission and Measurement. Definition of terms; power measuring devices and their theory of operation.

Soil Conditioning. Tilling, cultivating and fertilizing machinery; functional requirements; efficiency of performance.

Crop Planting. Types of crop planters; functional requirements of procession planting; efficiency of performance.

Crop Nurturing. Mechanical, chemical and heat control of weeds; advantages of each; problems in efficient use of such machinery.

Crop Harvesting. The agronomic and live stock requirements for crop harvestors; harvesting efficiency, its significance and method of measuring it.

Cost of Using Machinery. Fundamentals of cost calculation; basic assumptions made in determining farm operating costs; techniques in synthesizing total cost of using field machinery.

Selection and Management. Factors affecting capacity of field machinery; relationship of capacity to cost of operation.

Part (B)

Internal Combustion Engine. Its thermodynamics.

The Air Standarad Cycle. Otto and diesal and the actual deviation from the air standarad cycle.

Tractor, Car and Truck Fuels. Their characteristics, their differences and their basis of differences.

Carburation. Principals of carburation; misture proportioning by a simple carburetor; fuel supply to the carburetor; carburetor types and construction. The desired goals and the limitations in actual practice.

Lubrication of the I.C. Engine. Theory of lubrication; types of lubricant; their characteristics and limitations.

Tractor Ignition Systems. Battery and magneto ignition systems; their theory and construction.

Tractor Electrical System. Generator control techniques.

Power Transmission. Clutches; gearing; belt pulleys; draw bar, P.T.O. and hydraulic units. Performance and measurement of power.

Stability and Traction. Inter-relationship of traction and stability; mechanics of steering.

Review and Quizzes.

OUTLINE OF LABORATORY WORK

Part (A)

Use of an Operator's Manual and Service Manual for a field machine; getting acquainted with its contents.

Critical Evaluation of Tillage Methods including adjustment and operation of mold board plows, disc plows, rotary tillers and rice tillage.

Grain Drill Calibration; testing the accuracy of a grain drill's rate of seeding; evaluation of errors in the rate of study.

Study of Corn and Cotton Picker Machines; study of construction and adjustment; methods of testing efficiency of harvesting of a picker.

Crop Cutting Mechanism; study of their design differences; their functional requirements and their performance.

Small Grain Combines like Wheat and Rice; study of construction and their adjustments; construction of flow chart; method of testing harvesting efficiency of the combine.

Study of Planting of Wheat, Rice and Corn.

Crop Spraying Equipment; study of construction, operation and adjustments of various types of sprayers.

Capacity of Field Machines; problems in fundamental factors affecting the capacity of field machinery.

Part (B)

Valve Timing. The theory and technique of timing the valves of internal combustion engine.

Ignition System. Theory of operation and practice in timing the ignition system (battery and magneto).

Battery Charging Systems. A detailed study of various generator control systems for maintaining battery charge.

Tractor Hydraulic Systems. Study of the design, operation and adjustment of basic types of tractor hydraulic control units.

Power Management. A problem in the selection of a sufficient and economic power unit for a specified requirement.

Engine Fuel Economy Tests. The relationship between carburetor adjustment and fuel efficiency.

Measurement of Belt Horse Power by means of pony-brake dynamometer.

SAMPLE QUIZ

Time - One Hour — Total Points - 50

Points		
15	1.	Distinguish between (a) white or chilled cast iron and malleable cast iron, (b) carbon steel and alloy steel.
15	2.	Briefly describe two types of powered rotary tillers discussing their advantages and limitations.
20	3.	Compute the crank shaft-rear-axle speed ratio to give speeds of 2, 4.5 and 15 m.p.h. for a tractor having an engine speed of 2000 r.p.m. and rear wheels that are 46 inches in diameter.

SAMPLE FINAL EXAM

Time - Two Hours — Total Points - 100

Points		
15	1.	a. Derive the formula for the theoretical capacity of a machine in acres/hour. b. Define the formula to include time lost and length of the day and restate in actual acres/day.
15	2.	How much additional weight is needed on the rear wheels of a tractor to obtain 400 lbs. additional draw bar pull when the coefficient of rolling resistance between the rubber tires and ground is 0.65?
20	3.	Considering the question from an operating cost standpoint, set down the figures and prove which of these two "combines" the farmer should buy i.e. (a) a 12 ft. self-propelled combine which costs $3,000 or (b) a 6 ft. P.T.O. driven combine which costs $950. The farmer will have about 200 acres a year to combine. Make your assumptions as to travel speed, labor cost, tractor use, etc; the total annual fixed cost in percent of first cost for the two combines can be assumed to be 14 percent for the 12 ft. and 18 percent for the 6 ft. combine.
15	4.	What are the three types of engine lubricating oils and how are the following improved in lubricating oils? (a) Higher oxidation stability. (b) Corrosive resistance. (c) Antifoaming characteristics.
20	5.	a. What is a high speed engine and what are its distinguishing characteristics. b. Calculate the poinds of air required per hour by a four cylinder, four stroke engine with a 4 inch bore and 5 inch stroke if operated at 1000 r.p.m. and a volumetric efficiency

of 90 percent.

15 6. Briefly discuss the possibilities and limitations of a hydro-kinetic torque converter displacing the conventional change speed box on a farm tractor.

FARM IRRIGATION

General Information

1. Prerequisit - C.E. 212

2. Texts - (a) Irrigation Principles and Practices by Orson W. Israelsen and Vaughen E. Hansen
   (b) Sprinkler Irrigation by Guy O. Woodward

3. References - Irrication Engineering by Ivan E. Houk, Vol. I and II.

4. Quiz is to be scheduled after each one month or each two months for the evaluation of sessional marks.

OUTLINE OF THEORY COURSE

1.	Conveyence of Irrigation Water. Hydraulics of flow of irrigation water by pipe and open channel or a ditch. Location, layout and planning of farm irrigation ditches; lining canals; materials of lining; water conveyence structure.	2
2.	Water Measurement. Flow through an orifice; flow through a weir; effect of boundary form on coefficient of discharge; design and layout of farm irrigation water measuring devices such as weirs; parshall flume.	3
3.	Wells for Irrigation Water. Drilling methods and equipment; well casing perforations and screens; development of wells by pumping, surging and compressed air; water yields of wells; confined and unconfined wells; draw-down discharge relations; design of wells.	3
4.	Pumps. Power requirements and pumping plant efficiencies; pump characteristics; types of pujps; friction losses in pump systems; selection of power plant; irrigation pumping costs.	3
5.	Methods of Irrigation. Surface irrigation by flooding from field ditches; furrow irrigation; analysis of time to cover a given area with water; sub-surface irrigation; sprinkling irrigation; layout and design of the different systems.	3
6.	Measurement of Soil Moisture. Drilling holes and obtaining soil samples; gravimetric determination of moisture; tensiometers.	2
7.	Flow of Water into and Through the Soil. Energy in flowing water; piezometric measurement of pressure heads, in saturated soils; soil permeability measurement; intake characteristics of soils, measuring intake ratio.	3
8.	Salt Problems. Salinity; sources and accumulation of salts; movement of salts in soils; management of a high water table; reclamation and management of saline and alkali soils; saline water for irrigation; sources of salinity in water.	3

9. Consumptive use of Water. Conditions affecting consumptive use of water; direct measurement of consumptive use; climate and plant physiology related to consumptive use. 3

10. When to Irrigate and Quantity of Water Needed for Irrigation. Fall, Winter and Spring irrigation; limiting soil moisture conditions; available water supply; soil moisture removal by plant roots; effect of moisture content on rate of removal of soil moisture; effect of stage of growth on irrigation practice; frequency of irrigation; depth of water to be applied during irrigation. 4

11. Irrigation Efficiencies. Water conveyence and water application efficiencies; water use, water storage efficiencies; water distribution efficiency; consumptive use efficiency. 2

12. Sprinkler Irrigation. Types of sprinkler systems; sprinklers, nozzles; sprinkler laterals; couplers, fittings, valves, regulators and gauges; primers; portable main line and burried main line; pumping equipment for sprinkler irrigation; system control equipment; design of sprinkler system. 4

13. Planning, Operation and Maintenance of Farm Sprinkler System. Inventory of farm resources; determination of farm operations; design procedure; required operating instructions for system users; installation assistance; soil moisture control; maintenance of sprinkler irrigation equipment; some special uses of sprinkler irrigation equipment. 4

14. Review and Quizzes. 4

OUTLINE OF LABORATORY WORK

1. Studying characteristics of flow of discharge with respect to head in feet through (a) different types of orifices (b) different types of weirs. 2

2. Measuring discharge by means of Parshall Flume. Also studying the division of irrigation water. 2

3. Complete survey, design and recommendations if any for an (a) open ditch irrigation system of a particular area (b) a conduit irrigation system. 8

4. Study of different types of pumps used in irrigation. 2

5. Studying the pump characteristics as B.H.P., efficiency and head characteristics. 2

6. Comparison of the costs involved in irrigation by pumping and irrigation by open ditch system. 2

7. A problem on design and study of the water yield of an irrigation well. 2

8.	A tour of the irrigation systems prevalent in the area	2
9.	Study of the soil moisture tension with respect to soil moisture content (% of dryweight) based on the capillary action of water.	4
10.	A problem on the consumptive use of water based on inflow and outflow of different areas.	2
11.	Complete study and design of sprinkler system.	4
	Total Hours	75

SAMPLE QUIZ

Time - One Hour Total Points - 50

Points

15 1. a. Define irrigation and discuss various methods of irrigation.
b. List six good arguments for linning canals.

15 2. a. Discuss (i) deep-well turbine pumps, (ii) submersible turbine pumps. Discuss their construction and working.
b. What B.H.P. will be required to pump 500 g.p.m. against 200 p.s.i. when the pump efficiency is 70%.

20 3. a. List six methods of determining soil moisture content and discuss two of the methods which seem most important to you.
b. What suction pressure are you going to recommend through a pipe of 5 centimeters in diameter and a tensile force of 75.6 dynes/cm.

SAMPLE OF FINAL EXAM

Time - 2½ Hours Marks - 100

Note - Each Question Carries Equal Marks.

Points

10 1. a. An open ditch with a 4 ft. bottom and 1:1 side carries water to a culvert at 90 cfs. with a velocity of 2 ft. per sec. An open ditch with a 5' bottom and a 2:1 side slope carries the water away from the culvert in the discharge side at a velocity of 3' per sec. What diameter of virified clay pipe is needed if the culvert length is fifty feet?

10 b. You must select a measuring device to measure the flow in a canal carrying about 500 cfs on a 0.01% grade. The canal carries some sediment and bed load. List 5 measuring devices in order of best suitability.

6 2. a. Discuss development of wells.

4 b. Discuss flexible tubing for conveying water.

5 c. What are piezometers and why are they used?

5 d. Discuss infiltration and water movement during irrigation.

10 3. a. Determine the height of capillary rise in a tube where the angle of contact is 135 degrees and the surface tension is 0.075 gm/cm. The specific gravity of the liquid is 1.0 and the diameter of the tube is 0.2 cms.

10 b. For the same tube what would be the height of rise if the angle of contact is 90 degrees.

5 4. a. Define consumptive use.

5 b. Discuss the tank and lysimeter method of measuring consumptive use.

5 c. Discuss consumptive use by natural vegetation.

5 d. Discuss climate and plant physiology as related to consumptive use.

5 5. a. Discuss a non-saline alkali soil.
5 b. List five factors which affect the frequency of irrigation.
5 c. List ten particular advantages that sprinkler irrigation has over surface methods.
5 d. Discuss the border strip method of irrigation.

MATERIAL OF CONSTRUCTION AND FUNCTIONAL PLANNING OF FARM STRUCTURES A.E. 343

GENERAL INFORMATION

1. Prerequisit - M.E. 231

2. Text - Farm Structures by
   Barre and Sammet

3. References - (a) Farm Building Design by Neubauer and Walker
   (b) Ashre Guide and Data Book
   (c) Heat and Moisture Data for Poultry Housing by Longhouse, Ota and Ashbay, Agr. Engineering Journal, Vol. 41, No. 9, pp. 567-576. Sept. 196
   (d) Design Analysis for Poultry House Ventilation, M. L. Esmay, Agr. Engg. Journal, Vol. 41, No. 9, pp. 576-578. Sept. 196

4. Quiz may be given after one or two months each for the evaluation of sessional work.

OUTLINE OF THEORY COURSE

1. Selection of Materials in Relation to Use. Durability, hardness, toughness, resilience, wear resistance, workability, thermal characteristics, ease of cleaning, acoustical properties.

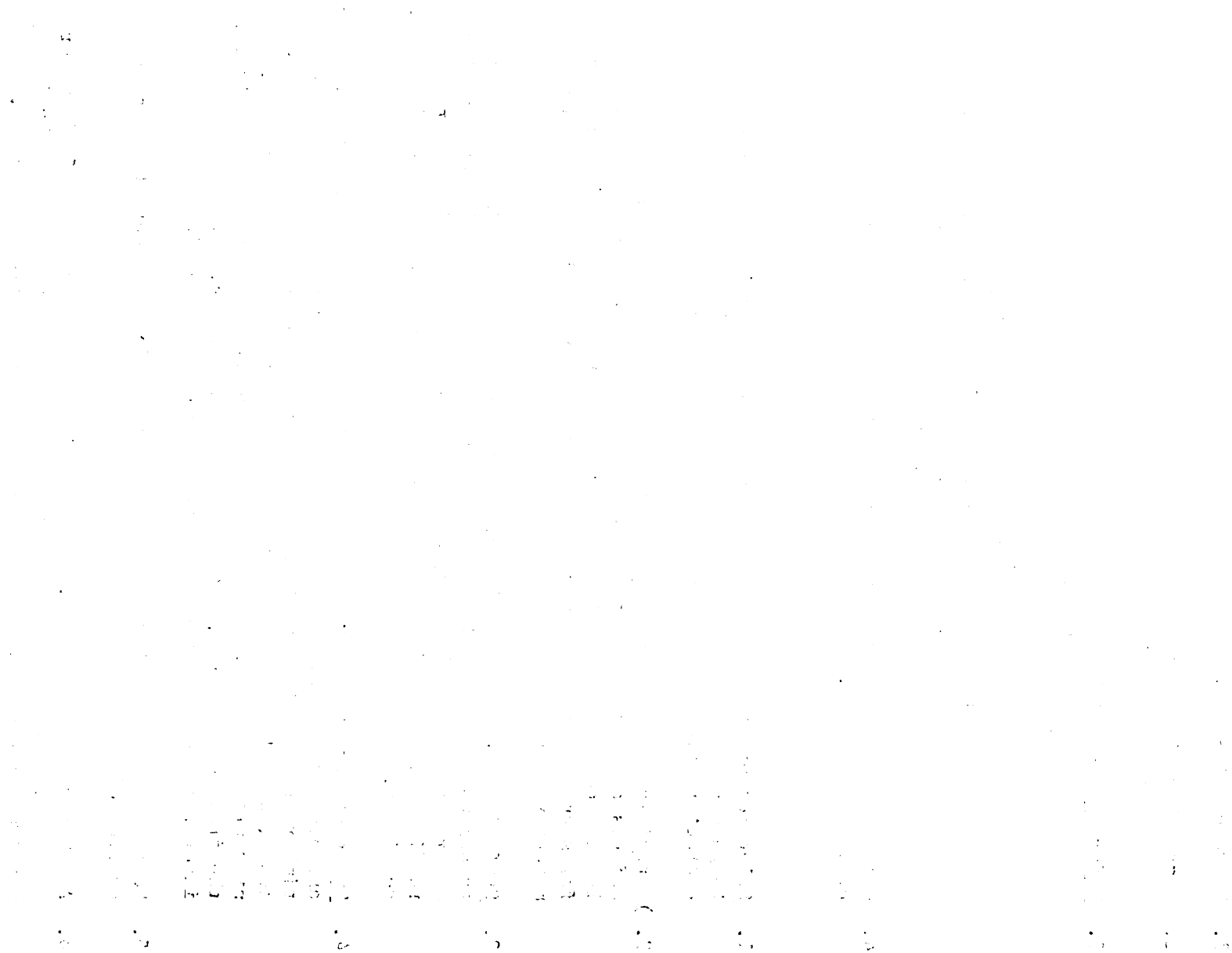
2. Materials and Methods of Use. (Wood, concrete, masonary) Growth defects and seasoning defects of wood; lumber grades; manufactured lumber; cement; aggregates; mixing of water; time of mixing, curing, forms and placing; masonary materials; mortar and joints; types of masonary units.

3. Surfacing Materials Detailing. Wall coverings as insulating boards, gypsum wall boards, plywood, cement asbestos boards, plaster, roofing materials as wood shingles, cement asbestos roofing, bituminous roofing; flashing flooring wood, concrete, stone, composition flooring, detailing.

4. Types of Structural Frames, Estimating Loads and Stress Analysis. Beam and post, truss, arches; rigid frame, silos, retaining wall, light timber framing, bracing framed structure; estimating dead load, line loads, wind loads, liquid pressure, pressure in granular material, pressure in deep bins. Conditions for equilibrium in stress analysis, the free body diagram, determining kind of stress, determinate and indeterminate structures, stress computations, graphic methods.

5. Heat and Heat Transfer. Conduction, radiation and convection; production of heat.

6. Air-Water Vapor Mixtures. Gas Equation, characteristics of air-vapor mixtures, relation between degree of saturation and relative humidity, psychrometric chart, enthalpy, cooling in adiabatic evaporation.



7. Heat Flow Through Walls and Estimating Heat Load. Conductance, combined conductance coefficient; heat load, design temperatures; solar radiation, sensible heat, seasonal heat load; degree day.

8. Condensation in Walls. Temperature gradient, surface condensation; condensation in building walls, control of condensation; vapor resistance required in vapor barrier.

9. Ventilation. Estimating quantity of air flow; heat balance in ventilation; ventilation systems, natural ventilation; forced draft systems.

10. Physiologic Reactions of Animals to Ambient Temperature and Relative Humidity. Homeothermic processes, physiologic response to change in environmental temperature.

11. Dairy Building. Functional planning, environment, sanitation, space requirement; insulation and ventilation, water supply.

12. Poultry Housing. Functional planning, production practices, environment, space requirements, arrangement of space, insulation and ventilation, other considerations.

13. Storage of Fruit, Vegetable Crops and Grains. Heat production of stored products, economic aspects of storage, characteristics of common storage, refrigerated storage, temperature and relative humidity; refrigerating load, analysis of refrigerating load, modified atmosphere storage, air movement, storage management; destructive agents of grain storage, respiration of grains, moisture and temperature changes in stored grains, moisture properties of grains, conditioning moist grains, storage structures.

14. Farm Houses. Functional Planning; organization and space arrangement: space requirement; site planning and orientation; general characteristics of the house.

15. Estimating Construction Costs. Preliminary estimates; detailed cost estimates.

16. Some Economic Aspects of Farm Buildings. Interpretation of Census values and expenditures for farm buildings; expenditure for farm buildings; depreciation of farm buildings and appraisal of present value; annual cost of the building; optimum investment in farm buildings.

17. Building and Farmstead Planning for Process Efficiency. Aids to planning for process efficiency; consideration in planning studies; farmstead planning.

18. Quizzes and Review.

OUTLINE OF LABORATORY WORK

1. Study of the use of local materials and a trip to the local materials yard.
2. Problems on heat transfer.
3. Problems on air-vapor mixtures and construction of psychrometric chart.
4. Calculation of heat flow through walls and estimating heat loads.
5. Problems on temperature gradients and condensation in walls
6. Design of wall sections to lower loss or gain of heat and to prevent condensation on surfaces and interior of walls.
7. Ventilation cumputation.
8. Designing and planning a dairy barn for cow and calf housing.
9. Planning and designing a poultry house.
10. Prepare floor plan for dwelling.
11. Computations on cost estimates.
12. Study and problems on grain storage.
13. Floor plan and flow diagram for a small milk plant.

SAMPLE LAB. PROBLEM

A calf housing facility has 22 calves (average weight is 150 pounds). The calf housing facility is 28' x 36' with an 8' ceiling. The ceiling has 6 inches of fill insulation and the side walls have a 2" blanket. The optimum conditions are 55° and 65% R.H. The sensible heat production for 100 lbs. B.W. at 55° equals 225 BTU/Hr.

a. How much air must be moved to remove the moisture when outside temperature is 30°F and 70% R.H.
b. What is the amount of air needed to maintain the desired room temperature.

SAMPLE QUIZ

Time - One Hour Total Points - 50

Points

15 1. What type of defects can you imagine in wood and what is the reason. Please explain.

15 2. Define ambient temperature and coeff of thermal capacity. Ice weighing 25 lbs. and at a temperature of 20°F is heated to 60°F. At which temperature is 10 lbs. of water evaporated? How much heat must be supplied in this process? Heat of vaporization is 97° BTU/lb.

20 3. One pound of dry air contains 0.05 lbs. of water vapor. The temperature of the mixture is 110°F. The pressure is 14.7 lbs./sq. inch absolute. Compute the partial pressure of water vapor. Determine the relative humidity.

SAMPLE OF FINAL EXAM

Time - 2 Hours Total Points - 100

Points

20 1. What is Basal Energy Metabolism and what is the effect of environmental temp on the productivity of poultry.

20 2. Discuss five functional requirements of a dairy barn. Also discuss pen versus stall barn.

20 3. Explain and discuss five important methods of preservation of stored crops.

20 4. Discuss at least four methods of conditioning the grain in the farm storage for removing the excess moisture.

20 5. (Open book)
A wall constructed of 3/4" wood lath and plaster (resistance = 0.40); 3 5/8" air space (resistance = 0.90); 3/4" fir sheathing and building paper plus lap siding (resistance = 2.0) has an inside surface resistance of 0.60 and an outside surface resistance of 0.10. If the inside temp is 70°F and the outside temp is 10°F, what will be the temp of the inside surface of the wall? What maximum relative humidity would be permissible assuming that no condensation will take place on the wall surface at that temp.

DIFFERENT MODES OF HEAT TRANSFER AND FARM PROCESSING A.E. 344

GENERAL INFORMATION

1. Prerequisit - C.E. 212

2. Texts - (a) Heat Transfer by J. P. Holman
   (b) Drying Farm Crops by Carl W. Hall
   (c) Methods and Equipment for Rice Testing by F.A.O.
   (d) Equipment for the Processing of Rice by F.A.O.

3. References - (a) Engineering for Dairy and Food Products by Arthur W. Farrall
   (b) Thermodynamics for Engineers by Doolittle

OUTLINE OF COURSE

1. Introduction. Conduction heat transfer, thermal conductivity, convection heat transfer, radiation heat transfer, dimensions and units. 1

2. Steady-State Conduction, One Dimension. The plane wall; radial system cylinders; plane wall with heat sources; cylinder with heat sources; conduction-convection systems; fins. 2

3. Steady-State Conduction, Two Dimension. Introduction; mathematical analysis of two-dimensional heat conduction. 3

4. Unsteady-State Heat Conduction. Dumped-heat-capacity system; transient heat flow in a semi-infinite plate; convection boundary conditions. 3

5. Principles of Convection. Viscous flow, inviscid flow; laminar boundary layer on a flat plate; energy equation of the boundary layer; thermal boundary layer; relation between fluid friction and heat transfer; turbulent boundary-layer heat transfer; heat transfer in laminar tube flow; turbulent flow in a tube; heat transfer in high speed flow. 4

6. Empirical and Practical relations for forced-Convection Heat Transfer. Empirical relations for pipe and tube flow; flow across cylinders and spheres; flow across tube banks; liquid-metal heat transfer. 3

7. Natural-Convection System. Free-convection heat transfer on a vertical flat plate; free convection from vertical planes and cylinders; free convection from horizontal cylinders; free convection from horizontal square plates. 3

8. Radiation Heat Transfer. Physical mechanism; radiation properties; radiation shape factor; relation between shape factors; heat exchange between nonblack bodies; infinite parallel planes; radiation shields; radiation heat exchange through an absorbing and transmitting medium. 4

9. Condensation and Boiling Heat Transfer. Condensation heat-transfer phenomena; boiling heat-transfer; simplified relations for boiling heat-transfer with water. 2

10. Mass-Transfer. Fick's Law of Diffusion; mass-transfer coefficient. 2

11. Refrigeration. Carnot cycle for refrigeration; vapor compression refrigeration; the actual vapor compression system; refrigerants; water-vapor refrigeration system; absorption system. 3

12. Gas-Vapor Mixtures. Definitions; psychrometric charts; humidification and dehumidification; cooling by evaporation. 2

13. Equilibrium Moisture Content. M.C. versus R.H.; determination of vapor pressure; determination of equilibrium moisture content; maintaining R.H. with a saturated salt solution or acid solution; heat of vaporization. 2

14. Moisture and Temperature Changes and Effects. Moisture migration; moisture content; temperature changes; prevention of moisture accumulation; heat transfer; transient heat transfer; periodic temperature variations; calculation of temperature in bin. 2

15. Theory of Drying. Rate periods of drying; determining periods of drying, thin layer drying; deep layer drying; application of Hukill's analysis to drying; use of psychrometric chart for analyzing drying. 4

16. Principles of Air Movement. Radial and axial flow fans; general fan principles; duct, floor and bin design; effect of material on air flow; measurement of static pressure; determining air flow from static pressure data. 3

17. Systems for Grain and Ear Corn Drying. Natural ventilation of ear corn; cribbing ear corn; forced air drying of grain; fan selection; method of air distribution; storage of grains and shelled corn; forced air drying of ear corn; use of heated forced air for grain and ear corn drying; cost of handling and forced air drying of grain and ear corn; aeration or mechanical cooling; farm and commercial storages. 3

18. Systems for Hay Drying. Field curing, crushing hay; respiration and mold growth; long, chopped and baled hay; designing a barn hay dryer; management of a hay dryer. 3

19. Dry, Condensed and Evaporated Milk Processing. Pasteurization, homogenization, cream separation and other dairy products. 4

20. Frozen Food Processing. Fruits and vegetables; meats and poultry; packaging, rates of freezing, computation of live refrigeration loads. 6

21. Paddy Sampling Techniques of Rice. Determination of foreign matter; determining moisture content; determining the purity of rice varieties; determining the milling quality of rice; drying paddy samples. 4

22. Review and Quizzes. 4

Total Number of Hours 67

OUTLINE OF LABORATORY

1. Determining the heating and cooling constants for a given piece of metal. Investigation of rate of cooling and time of one-half response by the use of potentiometer. 2

2. Problem. Analogy between cooling and drying. Newton's Law of Cooling. Drying lay and rate of drying as related to moisture content and vapor pressure difference. 2

3. Determining the drying constants for a grain sample. Rate of drying, time of one-half response and vapor pressure of grain. 2

4. Moisture Determination. Comparision of results obtained from various types of equipment available. 2

5. Determining the temperature, pressure and moisture gradients under actual drying conditions. Determining the effect of rate of air flow on power requirement. 4

6. Field trip to a government controlled farm to observe mow hay drying system. Inspection of hay cured by various drying methods. Discuss production results from feeding mow dried hay with dairy operator. 2

7. Problem. Application of theoretical drying curves to field conditions. Determining rates of drying in various zones in deep layer drying. Estimation of drying time. Moisture content of each layer. 2

8. Determining the moisture content of rice. 3

9. Inspection trip to a rice milling factory. 2

10. Inspection trip to a fruit and vegetable canning factory and a visit to cold storage. 2

11. Preparation of a report on personal investigation of any phase of processing farm products. 4

12. Inspection trip to a dairy to observe pasteurization, bottling, homogenization, butter and cheese preparation. 2

13. Problem. Floor lay out of a small processing plant. Unit processes and cost analysis. 4

Total Hours 33

Total Lab and Theory Hours 100

SAMPLE LABORATORY EXERCISE

Object - To determine the drying constant for ground shelled corn.

Materials - Drying oven, balance, drying pan, thermometer, ground corn.

Procedure - Weigh out 250 grams of ground corn. Place stock in drying pan suspended in the oven from the balance. Record the stock weight and oven temperature every 5 minutes for the first 30 minutes. Then every 10 minutes for the next 90 minutes. At the end of the two hour period leave the scales stock and oven undisturbed. The final reading will be made before the next lecture and the observation will be given to the students.

Determine vapor pressure of room and oven.

Report - Shall be a complete lab report in style. Plot on cartesian coordinates the weight of the sample against time. Plot on semi-log paper the percent moisture dry basis against time.

Questions - 1. What is the times of one-half and one-fourth response?

2. Determine the "K" value in the equation

$$M - Me = (Mo - Me)\, e^{-kt}$$

3. What is the rate of drying when the corn has reached 10 percent moisture dry basis?
4. What is the vapor pressure of the corn after 15 minutes of drying?

SAMPLE QUIZ

Time - One Hour Total Points - 50

Points

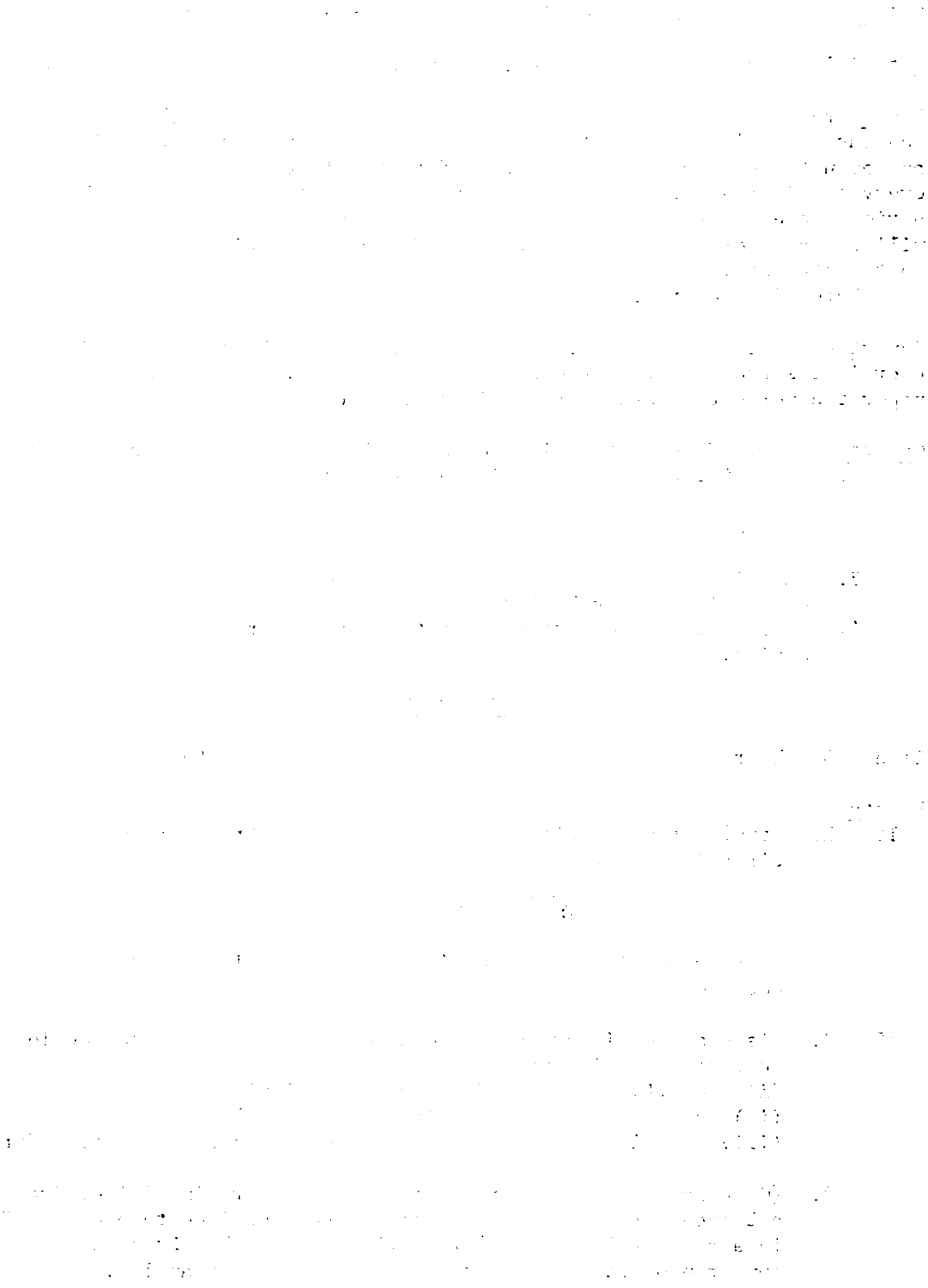
15 1. Develop the equation for conductive heat transfer in one direction, i.e.

$$\frac{\partial^2 T}{\partial X^2} = \frac{1}{\alpha}\frac{\partial T}{\partial t}$$

What assumptions are made in developing this differential equation.

15 2. Discuss the difference between forced and natural convection heat transfer in terms of:
(i) The B.L. thickness (temp and velocity)
(ii) The B.L. profiles (velocity and temp)
(iii) The dimensionless numbers determining the heat transfer

20 3. (Open book) Find the rate of heat loss per lineal foot from a 2 inch bare nominal steam pipe with a surface temp of 330°F in a room at 70°F and 14.7 P.S.I. The Grashof-Prandtal number product is greater than 10^4 and less than 10^9.



SAMPLE FINAL EXAM

Time - Two Hours Total Points - 100

Points

20 1. Develop an expression for temp distribution for a cylinder with a heat source and under steady state conduction.

15 2. A steel ball 2 inches in diameter, initially at a uniform temp of 850°F is suddenly placed in a liquid in which the temp is maintained at 200°F. The convection heat - transfer coeff is 2 BTU/hr-Ft^2-F. Density is 490 lbs. m/ft^3 and c = 0.11 BTU/lbm °F. Calculate the time required for the ball to attain a temp of 300°F.

20 3. Discuss the importance of a high carotene content in hay and the effect of the different systems of hay curing on the carotene content.

20 4. (Open book) Two parallel plates 6 by 8 ft. are spaced 5 ft. apart. One plate is maintained at 1200°F and the other at 500°F. The emissivities of the plates are 0.1 and 0.4, respectively. The plates are located in a very large room, the walls of which are maintained at 140°F. The plates exchange heat with each other and with the room. Find the total heat lost by the hotter plate.

25 5. Refrigerant F-12 enters a condenser at 120 p.s.i. and 130°F and leaves at 80°F. It enters the expansion valve at 76°F and leaves the evaporator at 25 p.s.i. and 20°F. Cooling water flows through the condenser at the rate of 1240 lbs./min., its temp increasing from 76°F to 88°F. Also 98 percent of the heat removed from the refrigerant in the condenser is removed by the water. Because of heat leakage into the evaporator, the net tonnage is 98.8 percent of the gross tonnage produced by the refrigerant. Determine the net tonnage.

SOIL PHYSICS AND DRAINAGE A.E. 441

GENERAL INFORMATION

1. Prerequisit -

2. Texts - (a) Soil Physics by Baver
(b) Engineering for Agricultural Drainage by Roe and Ayres

3. References - (a) Procedures for Testing Soils, Sponsored by A.S.T.M. Committee

4. Quizzes - To be given after each month or after each two months for the evaluation of sessional work.

OUTLINE OF THEORY COURSE

Soil Physics

1. Soil as a Disperse System. The relation of surface to particle size; clay - the active soil fraction; surface behavior of clay particles. 2

2. The Mechanical Composition of Soils. Preparation and fractionation of sample by different methods; Stoke's Law analysis based on complete separation of particles; analysis based upon the size distribution of soil particles; pipette and hydrometer methods. 4

3. Physical Behavior of Soil-Water Systems. The viscosity of colloidal clays; factors affecting viscosity of clays; the swelling of colloidal clays; soil consistancy; consistancy of moist and wet soils: plasticity; methods for determining soil plasticity. 4

4. Soil Water. Concepts of soil water; capillary potential; total potential: free energy concept; movement of water in the soil; hydraulic concept in moisture movement: water movement in saturated soils; hydraulic conductivity; permeability: movement of water in vapor phase; soil factors affecting evaporation; soil moisture constants; determination of soil moisture by various methods. 6

5. Soil Temperature. Sources and amount of heat; heat capacity of soils heat conductance and flow in soils; soil factors affecting heat conductance; daily and seasonal changes in soil temperature. 2

6. Physical Properties of Soils and Tillage. Soil tilth; measurement of tilth; plowing and the physics of plow action; preparing seed bed; cultivation; the compaction problem in soil tillage. 4

Drainage

1. Water Properties of Soils. Soil permeability; quantitative determinations of permeability; field measurement; direct and indirect measurement in laboratory; field measurements of "p" below shallow 2

water tables; forms of soil water; soil moisture characteristics; infiltration.

2. Rain Fall and Run Off. Precipitation characteristics; precipitation cycles; long-time records essential; measurement of rain fall; run off; evaporation; transpiration; deep seepage; factors influencing run off; large, medium and small agricultural water shed. 4

3. Major Types of Drains and Drainage Problems. Open channel type; subsurface drains; some special types of drains; drainage problems. 2

4. Design of Open Ditches. Factors in design; drainage surveys; equipment for drainage surveys; analysis of leading design factors; required capacity of the ditch; the drainage coefficient and its selection; Sutton's curves; the outlet; safe velocities of flow in open ditches; shape of cross-section of open ditches; side slopes; the roughness factor; character of the local rain fall; size, shape and topography of water sheds. 4

5. Location and Design of Under Drains. Out let; depth of outlet channel; pumping outlets for tile drains; classes of tile lines; laying out tile drains; gradient for the drains; length of tile lines; drainage coefficient "D" for the tile drainage; design of tile drainage; design of mains and sub mains; design of lateral systems; influence of the soil factor in tile drainage. Depth and spacing of tile drains on flat lands; special structures. 6

6. Drain Tiles. Classes of drain tiles; established sizes of drain tiles; kinds of drain tiles; special requirements for drain tile; action of soil sulfates on concrete; acid action on drain tiles; requisites for drain tile installation. 2

7. Drainage of Irrigated Lands. The functions of drainage on irrigated lands: high water table; seriousness of the seepage problem; control of high water table and alkali; canal linings, leaching and tile drainage and pumping for drainage; technical design of drainage of irrigated lands; illustrative random project. 4

8. Review and Quizzes. 5

SAMPLE LABORATORY

1. Preparing soil samples for mechanical analysis. 2

2. Determination of field moisture equivalent of soils 4

3. Tests for shrinkage factors determination of soils. 4

4. Determination of specific gravity of soils. 2

5. Tests for moisture-density relations of soils. 4

6. Separation and fractionation of clays and the associated material from soils. 4

7.	Determination of density of soils in place by use of sand.	2
8.	Determination of permeability and capillarity of soils and soil mixtures.	4

Drainage

1.	Plan and design open ditch drainage.	10
2.	Reconnaissance survey for tile drainage (field).	2
3.	Final survey for tile drainage (field).	2
4.	Plan and design a tile drainage system.	6
5.	Calculate and plot hydrograph and mass run off curves for a small water shed.	3
	Total Hours	100

SAMPLE QUIZ

Time - One Hour Total Points - 50

Points

15 1. What is meant by "analyses based upon separation of particles and analyses based upon the size distribution of particles of soil"? Discuss both shortly explaining how they are achieved.

15 2. What are the factors which affect viscosity of clays? Prove your answer by drawing some curves showing the effect.

20 3. List the three forms of soil moisture and under each outline the characteristics that pertain to it.

SAMPLE FINAL EXAM

Time - Two Hours Total Points - 100

Points

20 1. a. List and describe shortly the factors which affect the conductance of heat in soils.
b. Draw three curves each for (i) bare soil (ii) grass covered soil, to show the daily temperature changes of (i) air (ii) surface (iii) at a distance of approximately 4 inches inside the surface.

20 2. What are the ideal conditions for the preparation of seed beds? Discuss at least five of them.

15 3. List and discuss the factors which influence the rate of infiltration.

4. List the surveys that are necessary in planning a tile drainage system and itemize the information sought and work done in each.

5. (Open book)
The main ditch of an open ditch drainage system in Central Mississippi Basin empties into a small solugh that is to be excavated into a reservoir which can be of any depth desired. Design the ditch on the basis of the following information:

a. Ditch is 8 miles long and has a bottom slope of 2 feet per mile when it is 10 feet deep at the discharge end.
b. an n of .035 is applicable.
c. Soil type is sandy loam. Use side slopes and a velocity recommended for the soil.
d. Use a run-off based on Sutton's curve.
e. System drains an area of 60 sq. miles.

ADVANCED STUDY OF AGR. MACHINERY AND AGR. POWER A.E. 442

GENERAL INFORMATION

1. Prerequisit - A.E. 341

2. Texts - (a) Principles of Farm Machinery by Bainer, Kepner, Barger
(b) Elements of Internal Combustion Engines by A. R. Rogowski

3. References - (a) Farm Gas Engines and Tractors by Jones
(b) Mechanical Engineering handbook

OUTLINE OF THEORY COURSE

Part (A)

1. Tillage Force Analysis and Hitching. Multiple support force measuring devices; draft measurement; verticle and horizontal hitching; hitches for mounted implements.

2. Moldboard Type Tools. Functions and mechanics of tillage; moldboards under various soil conditions: pulverizing; turning and inversion. Forces acting upon a plow bottom; draft of plows.

3. Disk Tools. Standard disk plows; soil reactions on plow discs; hitching of trailed disc plows; disc harrows, forces acting upon a disc harrow; couples acting on disk-harrow gangs; penetration of disk harrows.

4. Miscellaneous Tillage Equipment. Rotary tillers, chisels and subsoilers; blade-type subsurface tillers; field cultivators; rod weeders; spike and spring-tooth harrows: rotary hoes and treaders; rollers and packers.

5. Growth Establishment Planters. Plant population requirement; plant surface profiles; mechanical functions of a seeding machine; seed metering devices; furrow openers; covering devices; solid planting; row crop planting; row crop drilling; check row planting; hill dropping; transplanting. Application of manure; commercial fertilizers; placement of commercial fertilizers; application of dry commercial fertilizers.

6. Growth Protection Sprayers. Methods of controlling weeds; row crop cultivation and its equipment; flame weeding; plant thinning; spraying and dusting; atomizing devices; pumps for sprayers; agitation of spray materials. Field sprayers; ground-rig dusters.

7. Handling System Components. Transport wheels; wagons and trailers; mechanical unloading; tractor-mounted loaders.

8. Harvesting and Preparation for Storage of Forage Crops and Kinematics of Reciprocating Parts. Hay harvesting methods; mowing; hay crushers; raking; types of side delivery rakes; desirable raking characteristics; analysis of raking action for finger-wheel rake; comparison of typical rakes; baling. Forage chopping and handling; basic components of choppers; gathering units; feed mechanisms; cutter head; chopping length; feed interference; elevating efficiency; distribution of power requirements; cutting, friction and kinetic energies; capacity of forage choppers; forage blowers.

9. Grain and Seed Harvesting. Harvesting and threshing methods; functional elements of a combine; flow path of material; types and sources of seed loss; cutting and conveying; threshing effectiveness; cylinder adjustment; separating and cleaning; performance of separating and cleaning units; power requirements of a combine; rice harvesting.

10. Corn Picking and Shelling. Types of machines; functional elements of corn harvestors; gathering devices and snapping units; types of snapping rolls; adjustments of snapping rolls; husking units; shelling and cleaning unit; field losses with corn harvestors; application of harvesting methods.

11. Harvesting of Other Crops. Mechanical cotton pickers; picker arrangements and basic requirements; mechanical strippers; factors affecting mechanical harvesting; effects and costs of mechanical harvesting; potato harvesting; sugar beet harvesting.

12. Seed Cleaning and Sorting. Screens; pocket type separators; inclined belts; spiral cones; separation on the basis of specific gravity; aspirating column; sorting on the basis of surface characteristics.

Part (B)

1. Physical Principles. Fundamental quantities; the gas laws; forms of energy; non-flow processes; flow processes; power and efficiency.

2. The Air-Cycle and Fuel-Air-Cycle Approximation. Construction of fuel-air charts; effect of engine variable.

3. The Actual Engine Cycle. Time required for combustion; effect of engine variables on flame speed. Other actual cycle losses. Power and efficiency of the actual cycle.

4. Engine Friction. Total engine friction. piston friction. Bearing and auxiliary friction. Pumping friction; important properties of oil.

5. Detonation. The importance of detonation; theory of detonation; results of detonation; effect of engine variables on detonation. Detonation rating of fuels; detonation control; recognition of detonation. Preignition.

6. Air Capacity. Estimation of air capacity; effect of engine variables on volumetric efficiency. Combined static and dynamic effects.

7. Fuel-Air-Ratio Requirements and Carburetors. Steady running requirements. Transient requirements. Distribution. Mixture control. The injection carburetor.

8. Spark Ignition. Requirements for ignition. Preignition. Ignition timing. Spark plugs. Standard battery ignition system. Magneto ignition system.

9. Heat Rejection and Cooling. Heat transfer theory. Effect of operating conditions. Temperature gradients in engine parts. Cooling.

10. Compression-Ignition Engines. Stages of combustion. Effect of operating variables. Fuel injection. Combustion chambers. Operation and performance.

11. Two-Stroke Engines. Two-stroke-engine types. Two-stroke air capacity.

12. Performance and Supercharging. Efficiency output. The performance map super charging.

13. Quizzes and Review.

OUTLINE OF LABORATORY

Part (A)

1. To describe the shape of the moldboard and the performance in the field of two plow bottoms of different shape and operated at two different speeds.

2. To make a force analysis on a plow as used in field with right rear wheel in furrow with the help of a dynamometer.

3. Callibration of a seed metering device.

4. To determine the influence of speed on planting accuracy in a corn planter.

5. Study of different types of seed metering devices.

6. Problem. Study of a grain combine and its system analysis.

7. Problem. Study of a corn harvesting combine and its system analysis.

8. To determine the influence of inclination and inlet length on auger capacity.

Part (B)

1. Dismantling various parts of the engine and then assembling the engine properly and see that the engine runs properly.

2. Study of the carburetter and its assembly.

3. Study of the battery and magneto ignition systems.

4. Study of spark advance on the engine.

5. Study of different types of cooling systems for engines.

6. Engine trouble shooting.

7. Performance characteristics of the engine including:

   a. I.H.P. by means of an indicator divice.
   b. B.H.P.
   c. I.M.E.P.
   d. B.M.E.P.
   e. Thermal efficiency.
   f. Specific fuel consumption.
   g. Mechanical efficiency.

SAMPLE LABORATORY

1. An engine does not start. Find out the cause of trouble.

   Procedure - Check if:

   a. Gasoline in carburetor or fuel pump not operating.
   b. Spark plugs or fuel injector defective.
   c. Wrong kind of fuel.
   d. Fuel valve closed.
   e. Fuel line closed.
   f. Carburetor overchoked or float stuck.
   g. Defective magneto or wiring.
   h. Engine speed control lever not advanced.
   i. Water in fuel supply.
   j. Gear engaged.
   k. Improper timing.

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k.

SAMPLE QUIZ

Time - One Hour Total Points - 50

Points

15 1. What is the reaction of the following soils to moldboard plow under the prevailing soil conditions?
   a. Hard cemented soils
   b. Heavy sod.
   c. Packed or cemented surface.
   d. Freshly plowed soil.
   e. Push soils.

15 2. Mention three types of seed metering devices and the method for adjusting the seed rate. Explain the working of one of the devices.

20 3. The total draft of a four bottom 16 inch moldboard plow when plowing 7 inch deep at 3.5 m.p.h. was 3400 lbs. Calculate
   a. The unit draft in p.s.i.
   b. Actual horse power requirement.
   c. If the field efficiency is 80 percent, what is the rate of work in acres/hour.

SAMPLE FINAL EXAM

Time - Two Hours Total Points - 100

Write True or False

Points

20 1. a._____. A disc plow pulverizes hard ground more readily than the moldboard plow.
   b._____. Individual plow bottom release is very important on five-bottom plows.
   c._____. The average knife velocity during the cutting part of the stroke is less than the average velocity during the stroke.
   d._____. The threshing in an ordinary combine is accomplished mainly by cylinder and concave.

20 2. Discuss five major operations performed by a combine and what are the factors on which threshing effectiveness depends.

20 3. An engine is used on a job requiring 150 B.H.P. The mechanical efficiency of the engine is 80 percent and the engine uses 110 lbs./hour under the condition of operation. A design improvement is made which reduces the engine friction by 7 H.P. Assuming the indicated thermal efficiency to be the same, how many pounds of fuel per hour will be saved?

20 4. A two cylinder engine has a total displacement of 300 cubic inches; runs at 2300 r.p.m. and develops 120 i.h.p.

a. What will be the total displacement of a similiar engine with six cylinders which will deliver the same i.h.p?
b. At what r.p.m. will it operate?

5. Draw five curves of H.P. versus road speed in m.p.h. for a typical automotive vehicle under the following gear ratio and throttle openings at a particular engine r.p.m.
a. Extra high gear ratio and full throttle.
b. Low gear ratio and full throttle.
c. Normal gear ratio and full throttle.
d. Normal gear ratio and part throttle.
e. B.H.P. versus piston speed in feet/minute.

RURAL ELECTRIFICATION A.E. 443

GENERAL INFORMATION

1. Total hours per week for lab. and theory - 3

2. Total number of weeks per year - 25

3. Prerequisit -

4. Texts - Farm Electrification by Robert H. Brown

5. References - (a) Farm Stead Wiring Hand Book
(b) Wiring Manual for Home and Farm

6. A quiz may be fiven after each month or after each two months depending upon the instructor, for the evaluation of the sessional work.

OUTLINE OF THEORY COURSE

1. Generation, Distribution of Power and the Electric Bill. Principles of distribution and terminology; transmission of electricity; use of energy by the electrical appliances; units of electrical energy; figuring the electric bill.

2. Electric Wiring. Circuit tracing; schematic ciagrams; series and parallel circuits; wiring diagrams; wiring principles for various outlets; reasons for grounding; ground connections; wiring materials for bonding; disigning the wiring for the dairy barn; designing the wiring system for the poultry farm. Electrical planning for the farm shop: electric wiring for the pump house.

3. Electricity for the Farm Residence. Planning the outlets; branch circuits required; selection of the service-entrance switch, number of branch circuits required and its ampere and wattage capacity; protection of the branch circuits; wiring supplies for the residence; modifying the existing wiring system.

4. Farm Stead Distribution System. Electric power requirement of various vuildings; type of distribution centers; locating the electrical load center; selection of the proper size wire for feeder lines.

5. Electricity for Light. Light, lumens, foot candles: quality of light; lighting methods; lighting design; lighting the farm home.

6. Electrical Controls for Farm Use. Switches; relays; push buttons, magnetic starting switch; reduced voltage starter; thermostat; pressure switch; solenoid valve.

7. Electrical Use for Heating and Cooling on the Farm. Heat and energy; electric heating elements; infra red lamps; electrical heating equipment; calculation of space heat losses; heat for farm applications; refrigeration principles; calculation of product and space load;

determining the size of the refrigerating unit; forced ventilation; ventilation requirements and practices.

8. Farm Electric Motors. Theory and operation of single phase motors; motor performance and selection according to the requirement; motor overload protection.

9. Electricity for the Rural Water Supply. Source of water and requirement of water; pumping fundamentals; operating principles of water pumps; pump selection; electrical features of water system.

10. Electricity for Special Equipment. Dairy farm equipment, electric fences; ensillage cutters and feed grinders; elevators; poultry farm equipment.

11. Review and Quizzes.

OUTLINE OF LABORATORY

1. Inspection, indentification and classification of electrical wiring fixtures and devices.

2. Design and layout of farm house wiring installation.

3. Design and layout of farm stead wiring installation.

4. Inspection of electric motors and electric motor control and overload devices.

5. Performance tests of electric motors.

6. Inspection of water system equipment and give a report on the working principles of one of the pumps.

7. Farm stead water pump performance tests.

8. Farm stead water system design.
   a. Farm house plumbing.
   b. Exterior plumbing

9. Inspection of lighting equipment.

10. Performance tests of selected lighting equipment.

11. Inspection of farm stead refrigerating equipment.

12. Performance tests of refrigerating equipment.
    a. Home freezers.
    b. Milk coolers.

13. Design and layout of a forced warm air heating system.

SAMPLE QUIZ

Time - One Hour Total Points - 50

Points

15 1. a. A certain motor has a power factor of 0.8 and is connected to 230 volts. The input current is 4.0 amp. Calculate the power input.
b. The electric motor of a certain desk fan is rated for 1/12 H.P. If the energy cost is 2¢ per Kwhr, what is the cost of operating this fan for 8 hours?

15 2. A pull chain lighting receptacle is installed over a sink. A wall switch controls a ceiling light in the same room. It is desired to eliminate the pull chain and control both lights from the one wall switch.
a. Draw the wiring diagram as it might be at present; then draw a second diagram for the proposed change in the wiring.
b. In the original wiring, how could one determine which outlet box contained the cable from the source.

20 3. (Open book)
A feeder line is to be constructed to serve a 6900 watt load. The length of run is 175 ft. The load is expected to use 300 Kwhr/month. Considering the initial cost of the wire and the killowatt hours lost in the lines, choose the wire size and the corresponding percentage voltage drop most practical for this application.

SAMPLE FINAL EXAM

Time - Two Hours Total Points - 100

Points

20 1. How many lumens pass through a spherical area of 0.3 m^2 having a radius of 4 m if an 800 candle source is at the center?

20 2. A proposed cooler for eggs is 6 by 6 by 8 ft. high. It has 4 inches of cork insulation. The refrigeration system must be capable of lowering the temperature of 180 lbs. of eggs from 100°F to 40°F in 1 hour. The room temperature is to be 40°F. What size refrigeration unit is needed if it is to operate 16 hours out of 24 hours?
Specific heat of eggs above freezing = 0.76, sp heat of eggs below freezing = 0.4.

20 3. The input to an electric motor is 5 KW at a power factor of 0.8. The motor is connected to a 240V source and the voltage drop to the motor is 2 percent. What is the resistance of each conductor?

20 4. It is desired to control the operation of a 1/3 H.P. motor

according to temperature in space. In addition it is desired to stop the motor if the pressure inside a certain gas line exceeds a safe valve. Show the schematic diagram for this arrangement. Use a type of pressure switch having contacts which are normally closed but open when the pressure is too high.

20 5. Sketch typical performance curves of total head versus capacity for:
a. A centrifugal pump.
b. A piston-type pump.
c. A gear-type pump.

PROJECT AND THESIS A.E. 444

1. References - (a) A. E. Hand Book by Richey, Jacobson, Hall
   (b) M. E. Handbook
   (c) Ashre Guide for a Refrigeration, Air Conditioning and Ventillation.

SAMPLE PROJECTS

1. Design of a rice sampling machine.
2. Design of a rice shelling machine.
3. Design of a forced air ventillated grain storage bin.
4. Design of a gravity air ventillated grain storage bin.