M.Tech Odd Semester (CBCS) Exam., December—2016

AGRICULTURAL ENGINEERING

(1st Semester)

Course No. : MAECF–01

Full Marks : 50
Pass Marks : 15

Time : 2 hours

Note : 1. Attempt *any* **five** questions.
2. Begin each answer in a new page.
3. Answer parts of a question at a place.
4. Assume reasonable data wherever required.
5. The figures in the margin indicate full marks for the questions.

Candidates of WRM will answer questions from MAE1CF–01, FPE students will answer from MAE2CF–01 and FMP students will answer from MAE3CF–01

WATER RESOURCE DEVELOPMENT AND MANAGEMENT

Course No. : MAE1CF–01

(On Farm Irrigation and Drainage Engineering)

1. Distinguish between the following : 10

(a) Venturi meter and water meter

(b) Soil-water potential and irrigation scheduling

(c) Broad-crested rectangular weirs and truncated flumes used for measurement in earth channels

(d) Irrigation mode and irrigation methods

2. Draw a layout for drip irrigation system with its components. A drip irrigation system is to be designed to irrigate 16·2 hectares of pasture on a silt loam soil. The intake rate of the soil is 15 mm/h. The available moisture-holding capacity of the soil is 150 mm/h. The depth of root zone is 0·6 m. Assuming a water application of efficiency 70%, determine—

(a) the limiting rate of the application;

(b) the irrigation period;

(c) the net depth of water per application;

(d) the depth of water pumped per application;

(e) the required system capacity in hectare per day. 10

3. *(a)* Express the relationship between pump speed and impeller diameter in the performance of centrifugal pump. 5

(b) A farmer desires to irrigate 10 hectares of land using a pump which operates 12 hours a day. The available moisture-holding capacity of the soil is 20 cm per metre of depth. The depth of root zone is 1·2 m. Irrigation is to be given when 50 percent of the available moisture is depleted. Assume that conveyance efficiency is 65 percent, application (clearly) is 75 percent and peak rate of moisture used by the crop is 5 mm per day. Determine its depth of irrigation, irrigation period and horsepower requirement if pumping plant efficiency is 60 percent and adequate stream is to be supplied at a total head of 10 m. 5

4. A centrifugal pump is required to deliver 27 lps of discharge against static suction and delivery heads of 6 m and 8 m respectively. The lengths of suction and delivery pipes are 8 m and 35 m respectively and the corresponding diameters are 125 mm and 100 mm. The suction pipe is fitted with a foot valve and strainer. The delivery pipe is fitted with one 90° long radius elbow and a 45° elbow. Calculate the HP of the pump if the overall efficiency of the pump is 50%. Given, the friction factor for suction and delivery pipes is equal to 0·03, foot valve and strainer

loss is equal to 0·70 m, coefficient k for 90° long radius elbow is equal to 1·44 and head loss for 45° elbow is equivalent to head loss in 5 m length of pipe. 10

5. *(a)* Write short notes on the following : 4

(i) Interceptor drains

(ii) Envelope materials

(b) Seepage from a canal is causing a drainage problem on adjacent land. The canal is 2.5 metres deep and rests on an impermeable layer. The water level in the canal is 2·4 metres above the bottom. The soil has a hydraulic conductivity of 20 mm/h. What will be the flow into an interceptor drain located 25, 50 and 100 metres from the canal? 6

6. *(a)* Write short notes on the following : 4

(i) Drain banks

(ii) Relief wells

(b) A layered soil consists of four layers of soil over gravel. Each soil layer is 50 cm thick. The hydraulic conductivities of the layers from top to bottom are K_1 0 5 cm/h; K_2 2 3 cm/h; K_3 2 0 cm/h and K_4 4 5 cm/h.

Water is ponded on the soil surface to a depth of 10 cm.

(i) What is the vertical permeability of the soil?

(ii) What is the pressure at the interface between layers (1) and (2)?

(iii) What will be the flow into the ground per unit area?

(iv) Assuming unit hydraulic gradient in a horizontal direction (no ponded water), what will be the horizontal flow per unit area? 6

7. *(a)* The EC of canal water used for irrigating wheat is 1·2 mmhos/cm while the crop can tolerate a maximum EC of 6 mmhos/cm. The evapotranspiration of wheat is 0·8 cm/day and soil hydraulic conductivity is 0·9 cm/h. The area is to be drained by tile drains laid at a depth of 2·5 m below ground level so as to maintain water table depth at 1·5 m. The impervious layer is located at a depth of 4 m below the ground surface.

(i) Compute the drain spacing using Hooghoudt's equation.

(ii) Calculate the drainage flow rate out of a 400-ha field. 5

(b) What are the requirements for surface and subsurface drainage systems? 5

8. The EC of irrigation water is 1·3 mmhos/cm. Assume a consumptive use of 3·5 inch/day, a crop tolerance of 6 mmhos/cm and a soil hydraulic conductivity of 0·3 cm/h. The drains are to be placed at 2 m and have a radius of 10 cm. The water table is not to be closer than 1·2 m from the soil surface. The impermeable layer is 6 m from the soil surface.

(a) Determine drain spacing.

(b) What will be the flow in cfs out of a 400-acre field?

(c) If the outlet is on a grade of 0·001, what size of pipe is required?

(d) If the water table rises to within 0·5 m of the soil surface following an irrigation, how long will it take for it to drop to 1·2 m below the soil surface? 10

FOOD PROCESS ENGINEERING

Course No. : MAE2CF–01

(Transport in Food Engineering)

1. *(a)* A composite wall consists of 1·5 mm of steel sheet and 10 mm of plywood separated by 2 cm of glass wool in between. Calculate the rate of heat flow if the temperatures on the steel and plywood sides are 25 °C and –15 °C respectively : 5

K for steel = 23·23 W/m °C
K for plywood = 0·052 W/m °C
K for glass wool = 0·014 W/m °C

(b) What is conduction heat flow? Derive conduction heat transfer equation for a sphere. 5

2. *(a)* What is molecular transport? Formalize general molecular transport by writing an equation. Also discuss heat transport. 7

(b) Explain Fick's law for molecular diffusion. 3

3. Derive a special case for diffusion of fluid through *(a)* stagnant and *(b)* non-diffusing fluid. 10

4. Derive an equation for velocity distribution of a fluid flowing in a circular tube in one-dimensional, steady-state, laminar flow. Also sketch the velocity and momentum flux profile for laminar flow. 10

5. *(a)* Define hydraulic radius. Write an equation for hydraulic radius of laminar flow in packed beds. 4

(b) Discuss continuity equation for simple mass balance on flow system. 3

(c) What is drag coefficient? Write an equation for total drag force acting on a solid body which is immersed in a fluid. 3

6. What is fluidization? Elaborate an equation for pressure drop and minimum fluidizing velocity for flow in fludized beds. 10

7. A packed bed is composed of cylinders having a diameter D 0 02 m and a length h D. The bulk density of the overall packed bed is 962 kg/m^3 and the density of the solid cylinders is 1600 kg/m^3.

(a) Calculate the void fraction ( ).

(b) Calculate the effective diameter D_p of the particle.

(c) Calculate the value of a ratio of total surface area in the bed to total volume of bed. 10

8. *(a)* Discuss equimolar counter diffusion for a binary mixture of gas. 7

(b) Write final equation for conduction heat flow through a cylindrical pipe. 3

FARM MACHINERY AND POWER

Course No. : MAE3CF–01

(Soil Dynamics in Tillage and Traction)

1. *(a)* What is shear strength? Draw typical shear stress-strain curves for soil. Explain the procedure for the determination of shear strength of soil by uniaxial shear strength apparatus. 7

(b) Write the advantages and disadvantages of uniaxial shear test. 3

2. *(a)* Explain the procedure to obtain the failure envelope, failure plane and principal stresses on the soil using a triaxial shear test. How do you determine the effective stress under various test conditions? 7

(b) Distinguish among various friction parameters of soil-tool interaction. 3

3. *(a)* In the consolidated-undrained triaxial test, two specimens were loaded to failure after consolidation under hydro-

static pressures of 200 kPa and 400 kPa, and the results are shown below :

Sample No.	*Hydrostatic pressure,* kPa	*Deviator stress,* kPa	*Pore-water pressure,* kPa
1	200	150	140
2	400	300	280

Calculate the *(i)* values of c and for total stress, *(ii)* values of c and for effective stress, *(iii)* maximum shear stresses for both specimens and *(iv)* shear and normal stress on the failure planes for both cases. 7

(b) Distinguish between shear failure envelope and shear failure plane. 3

4. *(a)* Determine the draft on a plane tillage tool inclined at 45°, operating at 25 cm depth in a cohesionless soil. The tool forward speed is 5 km/h. The soil density is 1·2 g/cm^3 and the angle of internal friction is 37°. The tool is 10 cm long and 25 cm wide, and the soil-metal friction is 0·3. Neglect adhesion, the cutting resistance and the effects of the tool supports. 7

(b) With neat sketches, explain the forces acting on the soil during interaction of tool during plowing. 3

5. *(a)* What is traction? Explain Coulomb's theory for the tractive force. Derive Bekker's theory for the rolling resistance of the tracks of the crawler tractor. 7

(b) Distinguish among a towed wheel, a self-propelled wheel, a braked wheel and a driving wheel. 3

6. *(a)* Explain Brixius model for the prediction of traction of a wheeled tractor. Explain the procedure followed for traction prediction using Brixius model. 7

(b) State Wismer-Luth theory of traction along with its limitations. Explain the variation in COT and tractive efficiency with slip. 3

7. *(a)* Explain the following : 7

(i) Mobility number

(ii) Rigid wheel

(iii) Elastic wheel

(iv) Carcass pressure

(v) Ground pressure

(vi) Slip

(vii) Tractive efficiency

(b) Write the differences between bias ply tyre and radial ply tyre. 3

8. Write short notes on the following : 5×2=10

(a) Recent advances in soil dynamics in tillage and traction

(b) Impact of recent research on vehicle design

★ ★ ★