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

AGRICULTURAL ENGINEERING

(1st Semester)

Course No. : MAECC–01

Full Marks : 50

Pass Marks : 15

Time : 3 hours

Candidates of WRM will answer MAE1CC01,
candidates of FPE will answer MAE2CC01 and
candidates of FMP will answer MAE3CC01

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.

WATER RESOURCES DEVELOPMENT
AND MANAGEMENT

Course No. : MAE1CC–01

(Hydrology and Water Resources Engineering)

1. (a) Describe different methods used for computation of mean areal precipitation. 5

(b) There are four rain gauge stations existing in the catchment of a river. The average annual rainfall values at these stations are 800 mm, 620 mm, 400 mm and 540 mm, respectively. Determine the mean, standard deviation, coefficient of variation and also optimum number of rain gauges in the catchment if it is desired to limit the error in the mean value of rainfall in the catchment to 10%. 5

2. (a) Define rainfall frequency and explain Weibull's method of frequency analysis. 5

(b) A dam has an expected working life of 25 years and is designed for a peak flood of 100 years return period. Estimate the risk of failure on this dam. If a risk of 12·5% is acceptable, what should be the return period? 5

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

(i) Structural analysis

(ii) Stationary series

(iii) Mean areal precipitation

(iv) Frequency distribution models

(v) Rational method

(b) At a station in Nainital tarai, it was found that 250 mm of rainfall has a return period of 25 years. Determine the probability of one-day rainfall which is equal to or greater than 250 mm, once in 15 successive years. 5

4. (a) Describe DRH and ERH. 5

(b) Write short notes on the following : 5
   (i) Curve number
   (ii) Hyetograph
   (iii) index
   (iv) Effective rainfall
   (v) Hydrograph

5. (a) Two rainfalls in magnitude of 3·5 cm and 1·75 cm have occurred consecutively at 6-h interval on a catchment area of 25 km^2. Compute the effective rainfall amount and index, if outflow hydrograph of catchment is as follows : 5

Time of rainfall (h)	0	3	6	9	12	15	18	21	24	27
Outflow (m^3/s)	5·5	7·5	15	21	30	25	20	5·5	5	5

(Assume base flow is constant at the rate of m^3/s)

(b) With neat sketch, explain various components of flood hydrograph. 5

6. (a) Describe that how a homogeneous earth dam differs with diaphragm type dam. 5

(b) Calculate the volume of excavation required for constructing a dugout farm pond if average depth of pond is 5 m, bottom width is 12 m, and bottom length is 25 m, side slope to be used as 2 : 1. 5

7. (a) Define the farm pond and write its importance. 5

(b) Write various design criteria of earth dam. 5

8. (a) Explain normal ratio method of estimating the missing rainfall data. 5

(b) Define mass curve and write its various uses. 5

FOOD PROCESS ENGINEERING

Course No. : MAE2CC–01

(Advanced Food Process Engineering—I)

1. (a) Calculate the steam consumption and the steam economy in a single-effect evaporator which is being used to concentrate a fruit juice. The juice enters the evaporator at 25 °C and a feed flow rate of 2 kg/s, the saturation pressure in the evaporator is 31·19 kPa, saturated steam at a pressure of 143·27 kPa is used as heating medium, the condensate exists at the steam condensation temperature, the heat capacity of the juice is 3·9 kJ/kg °C and 3·7 kJ/kg °C at the inlet and the outlet of the evaporator respectively, and the solids content is 10% and 20% at the inlet and the outlet of the evaporator respectively. 5

   (b) Discuss in brief the dynamic method of determination of equilibrium moisture content. 5

2. (a) It is desired to crush 100 tonnes/hour of food materials from a feed size where 80% is less than 101·6 mm to a product where 80% is less than 3·2 mm. The work index is 10·13. Calculate the

   power required and the power required to crush the product further where 80% is less than 1 mm. 5

   (b) Explain with the help of a neat figure various flow patterns of liquid in agitated vessel. Discuss the methods of prevention of swirling. 5

3. (a) The sterilization value of a process has been calculated to be F_0 of 2·88. If each can contain 10 spores of organisms having a D_0 of 1·5 min, calculate the probability of spoilage from this organisms and the % of inactivation of organisms. Assume that the F_0 value was calculated using the same Z value as the organism. 5

   (b) Describe the constructional details and working of single- and twin-screw extruders with the help of figures. 5

4. (a) Tomatoes of 250 kg with initial moisture content of 95% (wb) are freeze-dried. The final weight of the dehydrated product is 25 kg. Determine the final moisture content of the product, amount of water evaporated, and weight of bone dry product. 5

(7)

(b) With a neat figure, explain the working of homogenization process of milk. 5

5. (a) Wheat was ground using a burr mill, the screen analysis of the ground product is given in the table. Determine the fineness modulus and average particle size of the ground product : 5

IS sieve size	100	70	50	40	30	20	15	Pan
% material retained	0	3·5	6·0	25·2	42·8	19·2	2·3	1·0

(b) What are different types of flow in the extruder? Discuss the basic elements of proper extrusion-cooking of food products. 5

6. (a) A ball mill of 350 mm diameter charged with 150 mm balls was used for grinding of solid food materials. Calculate the critical speed and operating speed of rotation. What would be the operating speed of rotation for wet grinding in viscous suspension? 5

(b) With the help of a figure, discuss the working of forward and backward multiple -effects evaporators. Also describe their advantages and disadvantages in the application of food processing. 5

(8)

7. (a) Explain in-container sterilization and in-flow sterilization in regard to thermal processing of canned food. 5

(b) Differentiate between primary and secondary methods of moisture determination of agricultural products. Discuss the dielectric method of moisture measurement. 5

8. Write short notes on the following : 10

(a) Triple point of water

(b) Vacuum drying

(c) Hammer mill

(d) Deep bed drying

(e) Hybrid drying system

FARM MACHINERY AND POWER

Course No. : MAE3CC–01

(Design and Testing of Farm Power Systems—I)

1. *(a)* Derive the expression for the diesel cycle efficiency along with TV and TS diagrams. Draw the actual diesel cycle, and state the reasons for deviation of actual cycle from the idea cycle.   7

   (b) A diesel engine is to start at –7 °C. The polytropic exponent for compression is 1·25. The temperature at the end of compression is 900 K. If the compression ratio is 16, will the engine start? What should be the compression ratio for the start of the engine?   3

2. *(a)* Define and write the significances of the following :   1×7=7
   - *(i)* Octane number
   - *(ii)* Cetane number
   - *(iii)* Viscosity index
   - *(iv)* Flash point
   - *(v)* Pour point
   - *(vi)* Cloud point
   - *(vii)* Heating value

   (b) The diesel undergoes combustion in an engine with air supply of 5% greater than that theoretically required for

complete combustion. Assuming that all the hydrogen is burned and no free carbon is left in the exhaust, calculate the percentage analysis of the dry exhaust gases by volume. How much water is produced per kg of fuel burned?   3

3. *(a)* Explain the working of a hydraulic dynamometer. Describe Morse test for multicylinder engine.   4+3

   (b) The following observations were recorded during a trial on a 4-stroke diesel engine :

   Power absorbed by non-firing engine when driven by an electric motor = 10 kW

   Speed of engine = 1750 r.p.m.

   Brake torque = 327·4 Nm

   Fuel used = 15 kg/hr

   Calorific value of fuel
                   = 42000 kJ/kg

   Air supplied = 4·75 kg/min

   Cooling water circulated
                   = 16 kg/min

   Outlet temperature of cooling water
                   = 65·8 °C

   Temperature of exhaust gas
                   = 400 °C

Room temperature = 20·8 °C

Specific heat of water

= 4·19 kJ/kg-K

Specific heat of exhaust gas

= 1·25 kJ/kg-K

(i) Determine BHP, *(ii)* determine mechanical efficiency, *(iii)* determine BSFC and *(iv)* draw heat balance sheet on kW basis.　　3

4. *(a)* Explain the working principle of disc clutch. Derive the expression for the torque transmitted by the disc clutch by uniform wear theory.　　3+4

(b) A multiple-disc wet clutch is to be designed for transmitting a torque of 85 Nm. Space restriction limit the outside disk diameter to 100 mm. Design the values for the molded friction material and steel disks to be used are, coefficient of fiction = 0·06 (wet) and maximum pressure = 1400 kPa. Determine appropriate values for the disc inside diameter, the total number of discs, and the clamping force.　　3

5. Design a mechanical gear box for the tractor whose engine performance curves are shown in figure below. Assume the relevant data :　10
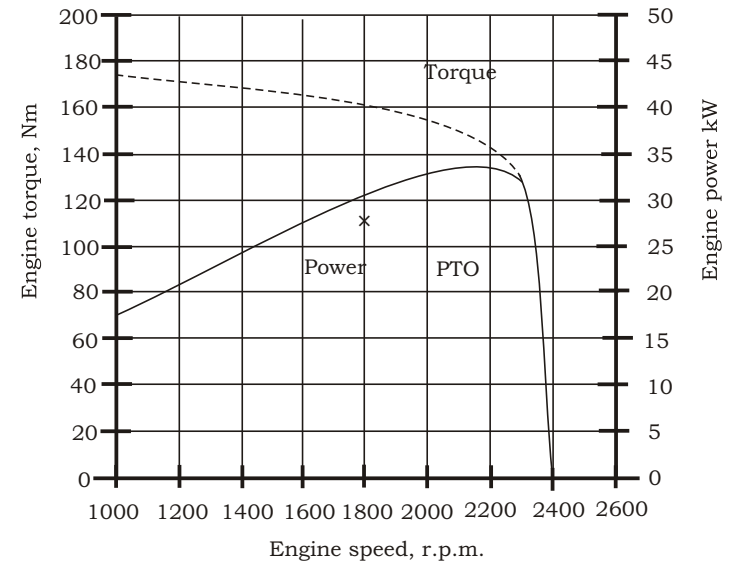
6. Explain the working of variable speed transmission. The inputs to a certain hydrostatic drive include torque of 250 N.m and speed of 2500 r.p.m. The drive includes a variable displacement pump, the displacement of which can vary from 42 cm^3/rev to 0 to 42 cm^3/rev in the opposite direction. Assume the volumetric efficiency of the pump and motor are each 0·97, while the torque efficiencies are each

0·93. The maximum permissible pressure drop across the motor is 35 MPa. If the motor has fixed displacement of 42 cm^3/rev, calculate the maximum *(i)* motor speed, *(ii)* motor torque, *(iii)* output power and *(iv)* transmission efficiency. Recalculate the *(v)* motor speed, *(vi)* motor torque and *(vii)* output power when the pump displacement is reduced to 4·2 cm^3/rev.   10

7. *(a)* Explain the working principle of tractor differential system. State the purpose of differential lock.   3

(b) The differential in the rear axle of a farm tractor has a ring gear with 39 teeth driven by a bevel pinion with 8 teeth. Each side gear is connected to a rear axle through a planetary gear set that provides a 4·94 : 1 speed reduction. If the input torque to the bevel pinion is 1500 N.m and the input speed is 525 r.p.m., calculate *(i)* the speed, *(ii)* the torque, and *(iii)* the power in each rear axle when the differential efficiency is 0·98 and the tractor is moving straight ahead on uniform, level ground.

Now, assume that the left wheel encounters poorer traction so that the left axle torque drops 10% and the left wheel begins turning 50% faster than the right wheel. If the pinion speed and

differential efficiency remain unchanged, calculate *(iv)* the speed, *(v)* the torque and *(vi)* the power in each rear axle.   7

8. *(a)* Draw the following curves for the tractor :   4

  (i) Forward speed and wheel slip versus drawbar pull curves in various gears

  (ii) Drawbar power versus drawbar pull in various gears

(b) Write short notes on the following :   6

  (i) Modern trends in tractor design and development

  (ii) Special design features of tractors in relation to Indian agriculture

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