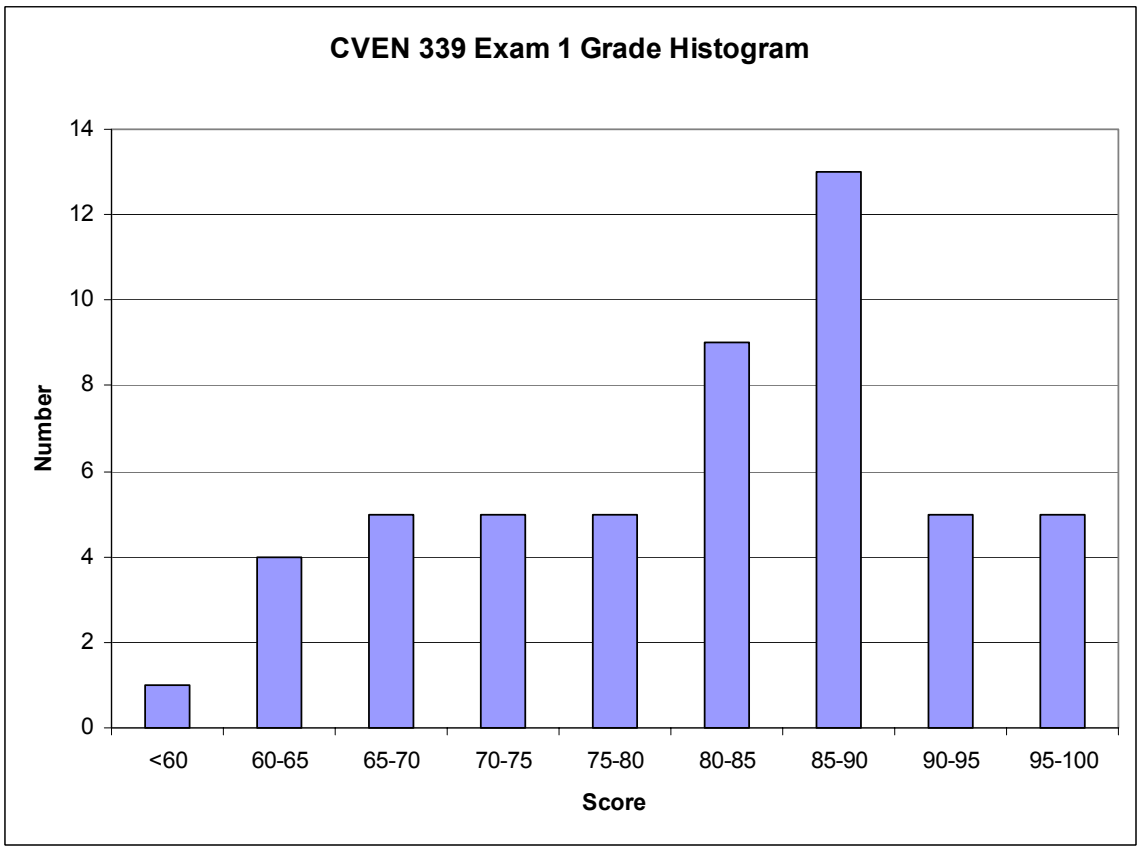
CVEN 339 – Exam #1 – Spring 2004

Grade Statistics

Median	83.75
Mean	81.1
Std. Dev.	11.1
Maximum	99
Minimum	50.3



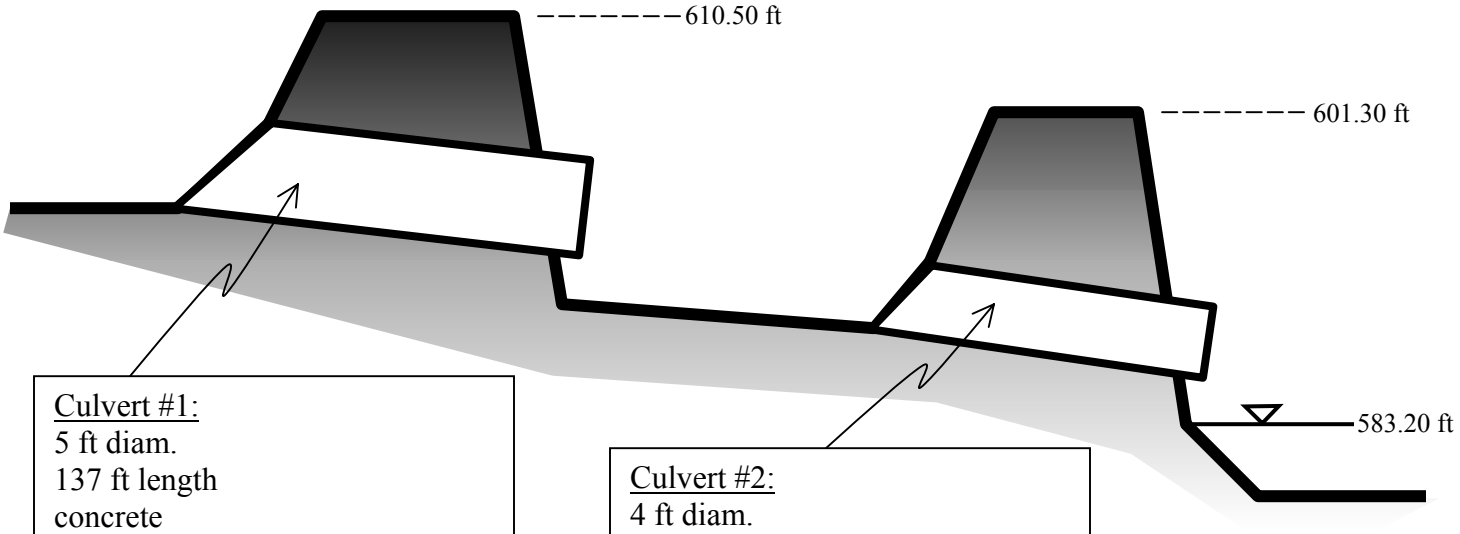
Name: _____

CVEN 339 – Water Resources Engineering
Spring Semester 2004
Dr. Kelly Brumbelow, Texas A&M University

Exam #1

Open-book, Open-notes (7 pages, 2 questions)

1. A four-lane highway is built with a median between two raised roadbeds (flat, no crowning). A small creek flows through a series of two culverts under the highway as shown in the diagram below. The median can store water and allow it to accumulate if outflow from the first culvert exceeds inflow to the second culvert; however, this could not occur indefinitely before water would flow over the top of the right roadbed. At the downstream end of the second culvert is a lake whose water surface elevation is expected never to exceed 583.20 ft. *What is the maximum steady-state flowrate guranteed to pass under the highway without water flowing over the top of either roadbed?* (40 points)



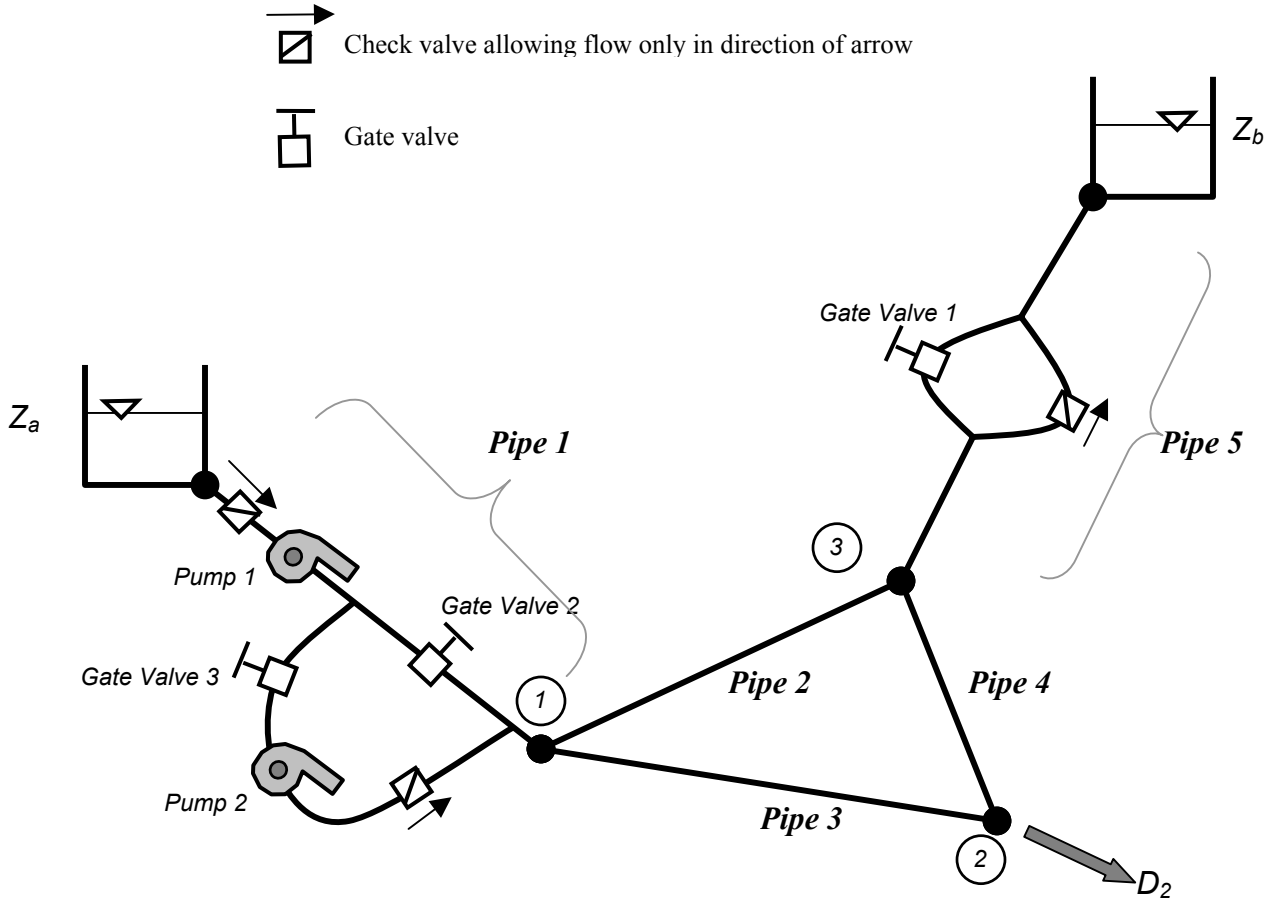
Culvert #1:
5 ft diam.
137 ft length
concrete
circular cross-section
mitered entrance w/out headwall
projecting exit
invert elevations:
entrance – 593.55 ft
exit – 592.05 ft

Culvert #2:
4 ft diam.
143 ft length
concrete
circular cross-section
mitered entrance w/out headwall
projecting exit
invert elevations:
entrance – 586.20 ft
exit – 585.15 ft

2. Diagrammed below is a simple pipe network system. The system has 2 different modes of operation: a *daytime* mode where most of the system's pressure and flow are supplied by the elevated tank, and a *nighttime* mode where the pumps provide all of the flow and pressure and the tank is refilled. At both the pumping station and the elevated tank are sets of valves that are opened and closed in the two modes to enforce flow directions and bring the second pump on- and off-line. Pump #2 is identical to Pump #1, so when they operate in series they function as a 2-stage pump.
When formulating the set of equations to describe this network, you may treat everything between Tank A and Node 1 as being a single pipe. You may also treat everything between Tower B and Node 3 as being a single pipe. It is important to change the characteristics of these two pipes appropriately between the day and night cases.

(a) *Write the set of equations that you will use to solve for system flows for (i) the daytime case and (ii) the nighttime case.* (30 points)
(b) If the correct flow in Pipe 1 is 0.98 cfs in the day and 22.91 cfs at night and the correct flow in Pipe 5 is 14.02 cfs in the day and 17.91 cfs at night, *what will be the flows in Pipes 2, 3, and 4 for (i) the daytime case and (ii) the nighttime case.* (30 points)

See next page for details.



	Daytime	Nighttime
Gate Valve 1	Open	Closed
Gate Valve 2	Open	Closed
Gate Valve 3	Closed	Open
Node 2 Demand (D_2)	15 cfs	5 cfs
Tank A elev. (Z_a)	100 ft	100 ft
Tower B elev. (Z_b)	200 ft	140 ft
Pump #1	On-line	On-line
Pump #2	Off-line	On-line

Pipes 1 and 5 may both be assumed to be 200 ft long no matter the state of valves along the pipe. Pipes 2, 3, and 4 are each 2000 ft long. All pipes are 24 inches in diameter and have friction factor $f = 0.013$. You should consider appropriate minor losses in your calculations.

Pumps #1 and #2 are identical, and each has the characteristic curve shown below.