**CSC148 – Quiz#2 – Tuesday Oct 8, 2019 NAME** \_\_\_\_\_\_\_Answers\_\_\_\_\_\_\_\_\_\_\_ Score \_\_\_/ Max: 18

Closed notes; NO mobile devices/calculators can be in-use during quiz

*An Appendix at the end of this document can be used/referenced for various questions, as applicable*

*\*\* Questions with phrase <Show work> require writing out steps to derive a result (not just writing down a number), ELSE credit loss \*\**

**Q#1 4 pts** You have collected data at a fast food drive through. The “system” S has a single drive-up waiting line, an order station, and only one additional window at which customers in vehicles vj pay and get their food order. ai, si, fi values were collected, per vehicle vi (*See Appendix for ai, si, fi definitions*)

**A ) 2 pts** Write an arithmetic expression for avg(vj wait time for service) in terms of the ai, si, fi, and the number of vi arrivals

avg(fi) – avg(ai), which is equivalent to ∑all vi (fi – ai)

**B ) 1 pts** In S, what distribution are vj interarrival times likely to follow ?

Exponential (= highly-variable interarrival times)

**C )** **1 pt** In one line, explain the difference(s), if any, between the distribution of service at the order station compared with the pay+get food window. If they are the same, answer “Same”

Probably both exp distributions, but with different means

**Q#2. 2 pts** Consider gpssW tr named “tr1” shown below. It wasexecuted using: Start 1000. Refer to an arrival as cj

tr1 generate 4 ; {ia} mean is 4 t.u.

seize svr ; cj waits until the server is free

advance 0.66 ; cj does some unspecified activity

release svr ; Free up server for other customers

terminate 1 ; cj leaves S

In the after-execution Report section about the server, fill in the 2 underlined items:

FACILITY ENTRIES UTIL. AVE. TIME AVAIL. OWNER PEND INTER RETRY DELAY

SVR xxxxxxx \_\_\_\_\_ \_\_\_\_\_\_\_\_ 1 0 0 0 0 0

We know that, for a single server, gpss UTIL. = the actual  = (1/4) / (3/2) = (1/6) = .1666 … (since each rate is the reciprocal of its mean)

AVE.TIME = avg(service duration) = 0.66 (= the specified service duration mean)

**Q#3 6 pts** A hps (refer to it as “2ps”) has degree 2. Customers cj queue for service in a single/common FIFO queue. This system S is observed for 10 t.u. The observation interval is [0,10].

Each horizontal axis displays arrival times akj and service finish times fkj for ck for the two servers svr1 and svr2.

Show work in all calculations.

a11 f11 a12 f12

svr1 0 1 2 3 4 5 6 7 8 9 10

a21 f21 a22 f22 & a23 f23

svr2 0 1 2 3 4 5 6 7 8 9 10

\*\*\* The notation f22 & a23 means that for svr2’s customers: c2 finishes at t=7 AND c3 starts at t=7

**A ) 2 pts** Calculate 

By definition it is (total number of aj) / (total model duration) = 5/10 = 1/2

**Q#3 B ) 2 pts** Calculate avg(Wcj) (as a numerical value)

= ( ∑ Wcj) / (number of cj) = (2=3+3+1+3)/5 = 12/5 = 2.4 t.u.

**Q#3 C ) 2 pts** Calculate avg(L) (as a numerical value)

The easiest solution uses Little’s Law, and parts A) and B) have already calculated the right side of the equation L = \*W =

(1/2)\*(12/5) = 6/5 = 1.2 cj

**Q#4 5 pts** In the service model below each cj encounters an hps followed by a facility (a sequence of services)

ps\_iaMean EQU 1.5 ; cjs {ia} times mean, assumed fixed, all model runs

ps\_svrMean EQU 6 ; ps service durations mean

ps\_x TABLE s$ps,1,1,15 ;

cjresDur QTABLE cjW,2,2,50 ; Distribution of cj residence duration

; Create and deploy the hps server

ps storage 32

makePSsvr generate 0,,0,1,1 ; Create n ps servers one time with a run-once tr

enter ps,32 ; Allocate all processes for ps

terminate

cjRequest generate (Exponential(1,0,ps\_iaMean)) ; Exponential {ia} distribution

queue cjw ; Start gathering W stats

tabulate ps\_x

test GE s$ps,1 ; Wait here until >= RequestSize process are free

leave ps,1 ; Start cj use of one hps server

advance (Exponential(1,0,ps\_svrMean)) ; Do ps service

enter ps,1 ; Finished service, so de-allocate the ps server

seize svr ; cj gets facility service

advance 1 ; Do facility service

release svr ; Free the facility

depart cjw ; Finished gathering W stats

terminate 1 ; This cj leaves S, & decrease tc

**A ) 2 pts** The distribution of what random variable is displayed by the histogram for table ps\_x? *Hint: Appendix functions on a STORAGE entity*

The current number of free hps servers in server ps

**B ) 4 pts** Calculate the utilization of the hps (not the facility). Show work here =>

We have proven that  =  / (deg \* ) for an hps server with degree “deg”. In the source code, deg = 32, and the arrival rate is 1/1.5 = (2/3), and the service rate = 1/6, so  = (2/3) / (32\*(1/6) ) = (2/3)/(16/3) = 1/8 = 0.125

Appendix

t.u. – specified/defined time unit for a model/simulation of system S (same as the time duration of one model clock tick)

tr – abbreviates “transaction”, and is gpssW terminology for the source code of an entity x that represents x’s behaviors/actions in

a simulation; so far, each tr consists of a sequence of blocks: GENERATE . . . TERMINATE n

x^ is the statistical value of x from a model run. Example: L^ is (average value of L during a model run)

cj – the jth customer that arrives in a system model

aj – arrival time of cj

sj – start service time of cj

fj – finish service time of cj

{iak} – sequence of cj interarrival times

– arrival rate of customers into a system S, same as (number of cj arrivals per t.u.)

– service rate of customers (at some specified server) in a system S (same as number of cj service completions per t.u.)

util – abbreviates “utilization”, and is (% of time a service entity is busy);

also, mathematically, util =  / (nps\*), where nps is the degree (aka number) of the server

W – residence duration; Wcj – residence duration for customer cj

avg(Wcj) = average customer residence time over a model run

n(t), aka L(t) – the number of cj in S at model time t

avg(L), often written simply as L – average number of customers in S

k(t) – the number of cj that have arrived in system S in time interval [0,t]

T – total time duration of a model run (same as model finish time)

RNk – gpssW random number generator 1 <= k <= 8

pmf – stands for the Probability Mass Function (aka density function) for a random variable x having a given distribution; that is, it is the function consisting of all (xi,prob(xi)) where xi is the ith possible domain point and

prob(xi) = probability that x = xi.  
hps – homogeneous parallel server (having some number >=1 of identical servers)

nps – the “degree” of a hps is the number of servers in that service entity

 / (deg \* ) – the utilization of a server with parallel degree “deg”

s$hpsName – the current number of free servers in hps named hpsName

r$hpsName – the current number of busy servers in hps named hpsName

gpssW built-in function call for an exponentially-distributed value having mean expMean:

(Exponential(1,0,expMean)) *{using RNG RN1, and 0 scaling}*