COMMERCE MENTORSHIP PROGRAM

MIDTERM REVIEW SESSION

COMM 204

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PRACTICE QUESTION 1: FLOW CHART, CAPACITY RATE, BOTTLENECK ANALYSIS

PRACTICE QUESTION 1 ANSWER KEY:

Place order → Toast buns → Sear meat patty → Add dressings → Packaging → Deliver

Resource	Cashier	Worker 1/Toaster	Worker 2	Worker 3	Worker 4	Worker 5
Flow time	12 sec	16 sec	15 sec	12 sec	12 sec	5 sec
Capacity Rate	300/hour	225/hour	240/hour	300/hour	300/hour	720/hour

a) Flow Time: 12+16+15+12+12+5 = 72 seconds
b) Bottleneck activity: Toasting buns - flowtime: 16 seconds
c) Capacity rate of worker 4: 1/12*60*60 = 300 units/hour
d) Capacity rate of process = Capacity rate of bottleneck activity = 1/16*60*60 = 225 units/hour
e) He needs to adjust the bottleneck activity by either:
    i) Adding more toasters (increasing resources)
    ii) Reducing unit load of the toaster
    iii) By adding one more toaster
        1) New capacity rate of toasting buns: 225*2 = 450 unit/hour
        2) New bottleneck: Searing meat patty (240 units/hour)
        3) New Flowtime: 72 seconds
            (a) Increasing resources does not affect Flowtime
f) Shortening non-bottleneck tasks decreases flow time but does not affect capacity rate of the whole process, therefore, the bottleneck would still be bun toasting
g) He is incorrect, because increasing resources does not affect Flowtime

PRACTICE QUESTION 2: THROUGHPUT RATE & UTILIZATION

PRACTICE QUESTION 2 ANSWER KEY:

Place order → Toast buns → Sear meat patty → Add dressings → Packaging → Deliver

Resource	Cashier	Worker 1/Toaster	Worker 2	Worker 3	Worker 4	Worker 5
Flow time	12 sec	16 sec	15 sec	12 sec	12 sec	5 sec
Capacity Rate	300/hour	225/hour	240/hour	300/hour	300/hour	720/hour

- 6pm
  - Input rate: 250 students/hour
  - Capacity rate of the process: 225/hour
    - Throughput rate of the process: 225 students/hour
  - Utilization rate: 225/225 = 100%
- 9am
  - Input rate: 200 students/hour
  - Capacity rate of the process: 225/hour
    - Throughput rate of the process: 200 students/hour
  - Utilization rate: 200/225 = 88.88%

PRACTICE QUESTION 3: THROUGHPUT RATE, UTILIZATION & INVENTORY BUILDUP DIAGRAM, LITTLE'S LAW

Practice Question 3 Answer key:

a) Time stamps!

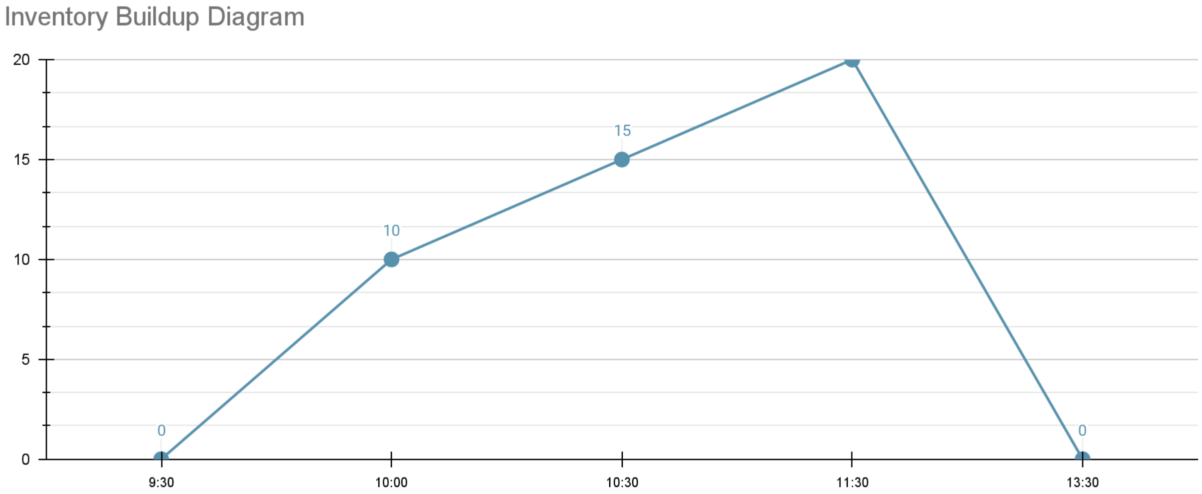
   i) **9:30am - 10am:**
      1) Customers started lining up at 9:30am, inventory at 9:30am is 0
      2) Arrival rate: 20/hour; Service rate: 0/hour,
      3) Inv @ 10am = 20 (customers/hour) * 0.5 (hour) = 10 customers

   ii) 10am - 10:30am
      1) Arrival rate: 20/hour; Service rate: 10/hour,
      2) $I(10{:}30am) = I(10am) + \Delta R \cdot (10{:}30am - 10am)$
      3) $\Delta R = 20 - 10 = 10$ customers/hour
      4) Inv @10:30am = 10 + 10*0.5(hour) = 15 customers

   iii) 10:30am - 11:30am:
      1) Arrival rate**:** 15 customers/hour; service rate: 10 customers/hour
      2) $I(11{:}30am) = I(11am) + \Delta R \cdot (11{:}30am - 10{:}30am)$
      3) $\Delta R = 15 - 10 = 5$
      4) Inv = 15 + 5*1(hour) = 20 customers

   iv) 11:30 onwards:
      1) Arrival rate: 0 customers/hour; service rate: 10 customers/hour
      2) Draw a line with a slope of -10/hour
      3) Since there were 20 customers waiting from 11:30, it would take 20/10 = 2 hours to process

v) Inventory build-up Diagram



vi) Average Inventory = Area under curve

1) 9:30am - 10:00am: 0.5(hour) * 10 * 0.5 = 2.5
2) 10:00am - 10:30am: 0.5 (hour) * (10+15)/2 = 6.25
3) 10:30am - 11:30am: 1 (hour) * (15+20)/2 = 17.5
4) 11:30am - 13:30pm: 2 (hour) * 20/2 = 10
5) Avg Inv = (2.5 + 6.25 + 17.5 + 10)/4 = appox. 9 customers

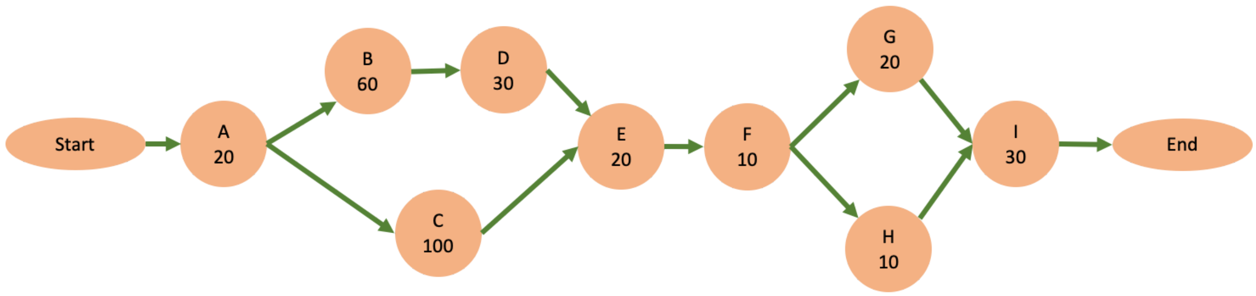
b) Between 9:30 am 13:30pm, there are 20 + 15 = 35 customers
Throughput rate = 35 customers / 4 hour = 8.75 (customers/hour)
Little's Law tells us: I = R * T
Average Flow Time = Avg Inventory / Throughput rate = 9/8.75 = 1.02 (hours)

PRACTICE QUESTION 4: CRITICAL PATH ANALYSIS

PRACTICE QUESTION 4 ANSWER KEY

Node	Activity	Time (days)	Precedence
A	Planning	20	None
B	Purchasing location	60	A
C	Excavation	100	A
D	Purchasing Materials	30	B
E	Building the frame	20	C,D
F	Assembly	10	E
G	Painting walls	20	F
H	Interior placements	10	F
I	Decorations	30	G,H

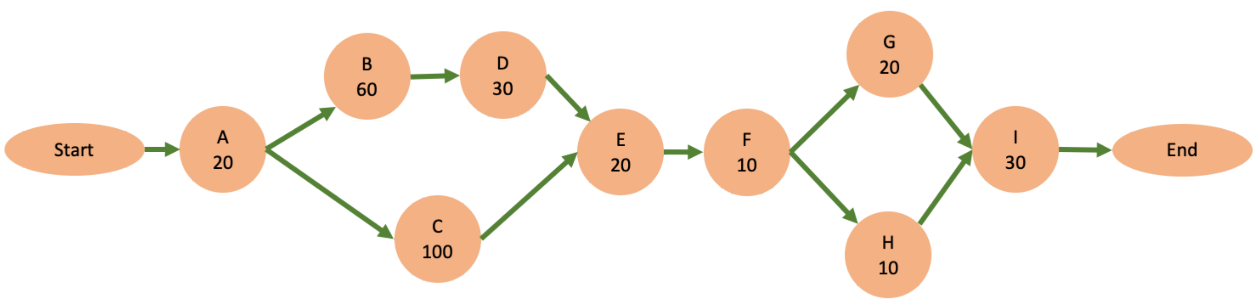
- **A-C-E-F-G-I = 20 + 100 + 20 + 10 + 20 + 30 = 200 (days)**
- A-B-D-E-F-G-I: 190 days
- A-B-D-E-F-H-I: 180 days
- A-C-E-F-H-I: 180 days



PRACTICE QUESTION 5: COSTING, CRASHING ACTIVITIES (continued from last question)

PRACTICE QUESTION 5 ANSWER KEY

Node	Activity	Time (days)	Precedence	Cost	Crash time	Crash Cost	Crashable time (Time – Crash time)	Cost increase (Crash cost – Cost)	Cost/day (Cost increase / Crashable Time)
A	Planning	20	None	$300	15	$450	5	$150	$30/day
B	Purchasing location	60	A	$2,100	50	$2,140	10	$40	$4/day
C	Excavation	100	A	$4,000	75	$4,500	25	$500	$20/day
D	Purchasing Materials	30	B	$2,850	20	$3,000	10	$150	$15/day
E	Building the frame	20	C,D	$500					
F	Assembly	10	E	$200					
G	Painting walls	20	F	$400	Cannot be crashed				
H	Interior placements	10	F	$600					
I	Decorations	30	G,H	$1,350					



Using the scorecard:

Step 1: Identify all paths (4 options):

- G > H -> Pick G
- B + D < C -> Pick C
- **A-C-E-F-G-I = 20 + 100 + 20 + 10 + 20 + 30 = 200 (days)**
- A-B-D-E-F-G-I: 190 days
- A-B-D-E-F-H-I: 180 days
- A-C-E-F-H-I: 180 days

Step 2: Identify Critical path

Step 3: Identify Crashable Activities based on Critical Paths

- A ($30/day) and C ($20/day)

Step 4: Crash the cheapest activity to match the second longest path

- Choose C and crash 10 days

- Note: If there are multiple critical paths in this step, must crash all critical paths

Step 5: Update the total cost

- 10*20 = 200 => $12,300 + $200 = $12,500

Step 6: Calculate the remaining crashable days of the activity

- Activity C: 25 - 10 = 15 (days remaining to crash)

Step 7: Repeat from step 1 until you reach the desired # of days!

Step 5: Cost	Step 6: # Days	Step 2: Critical Paths	Step 3: Crashable Task	Step 4: Best option	Step 1: All paths
$12,300	200	A-C-E-F-G-I	A (5 days @ $30/day) & C (25 days @ $20/day)	C for 10 days	**A-C-E-F-G-I: 200 days** A-B-D-E-F-G-I: 190 days A-B-D-E-F-H-I: 180 days A-C-E-F-H-I: 180 days
$12,500	190	A-B-D-E-F-G-I and A-C-E-F-G-I	A (5 days @ $30/day) & B (10 days @ $4/day) & C (15 days @ $20/day) & D (10 days @ $15/day)	B & C for 10 days	**A-C-E-F-G-I: 190 days** **A-B-D-E-F-G-I: 190 days** A-B-D-E-F-H-I: 180 days A-C-E-F-H-I: 180 days
$12,740	180	A-B-D-E-F-G-I and A-C-E-F-G-I	A (5 days @ $30/day) & B (0 days @ $4/day) & C (5 days @ $20/day) & D (10 days @ $15/day)	A for 5 days	**A-C-E-F-G-I: 180 days** **A-B-D-E-F-G-I: 180 days** A-B-D-E-F-H-I: 170 days A-C-E-F-H-I: 170 days
$12,890	175				**A-C-E-F-G-I: 175 days** **A-B-D-E-F-G-I: 175 days** A-B-D-E-F-H-I: 165 days A-C-E-F-H-I: 165 days

PRACTICE QUESTION 6: P-K FORMULA

PRACTICE QUESTION 6 ANSWER KEY

A) λ = 50/hour μ = 60/hour   Iq = ?   Tq = ?

For exponential distributions, mean = std dev

This is a M/M/1 queue, therefore:

Iq = 50^2 / 60(60-50) = 25/6

Tq = Iq / λ = (25/6)/50 = 1/12

B) λ = 4/hour   E[a] = Tq = ¼ hour σ[a] = 5/60 = 1/12 (hour)

μ = 6/hour = 1/Ts   E[s] = Ts = 1/6 (hour) σ[s] = 3/60 = 1/20 (hour)

$\varrho = \lambda / \mu$ = 4/6 = ⅔

Ca = σ[a] / E[a] = (1/12) / (¼) = ⅓

Cs = σ[s] / E[s] = (1/20) / (⅙) = 3/10

This is a G/G/1 queue, therefore:

$$I_q \cong \frac{\rho^2}{1-\rho} \times \frac{C_a^2 + C_s^2}{2} = \frac{(2/3)^2}{1/3} \times \frac{(1/3)^2 + (3/10)^2}{2}$$

Iq = 0.1340

Tq = Iq / λ = 0.1340 / 4 = 0.0335

C) λ = 4/hour

Ts = ⅙ (hour) -> μ = 6/hour

This is an M/D/1 queue as inter-arrival times follow an exponential distribution, and service time is contant

Iq = 4^2/(2*6(6-4)) = ⅔

Tq = (⅔)/4 = ⅙

T = Tq + Ts = ⅙ + ⅙ = ⅓