Numerical Problems on Scheduling Algorithms.
1. FCFS [Also called as FIFO] First come First Sewed]. >> Non- preemptive Algorithm.
Problem (1) constder the following set of process that Assives at time of milliseconds with
the length of the CPU Burst Time given in MIIIP se conds. Calculate the Average wasting Time.
Process Bust Time P1 14 P2 2 P3 4
Solution: - Step 1. GANTT Chart. P2 P3 P1 P4 16 20
Step 2: Waiting Time Averase Waiting Time Process Waiting Time > 0+14+16 = 30 = 10 P1

Problem (2) FCFS Page (2) If the processes changes their Order of Assive P.e. P2, P3 P1 Then the Results Will be different Calculate Waiting Process Burst Time Time and Average P2 waiting Time. PS 4 P1 14 Solution: - Step 1. GANTT Chart waiting Time (WT) waiting Time Phocess 6 P1 P2 2 P3 Step 3 Average Waiting Time (AWT) AWT = Sum of P1 P2 P3 waiting Time $=\frac{6+0+2}{3}=2.666$ Millise conds.

Pase

Problem (3) FCFS

page(3)

Consider the following set of processes that allive at time o, with the length of CPU Burst Time given & milli seconds. Calculate the Average Waiting Time when the Processes austre En the following order. P1, P2, P3, P4, P5. Provide Gant chast. Solution Step 1 Gantt Chart.

7000,10.1)		1 01	P5	1
1 Da I P	2 P3	14	177	22
[P2]	1'1	14	111	
A 4	. J L	18 J		

Step 2 Waiting Time (WT)

PLACESS	Waiting Time
P1	0
P2	4
P3	11
P4	14
P5	17
	0 10 0

Average Waiting Time (AWT) ANT = 0+4+11+14+17

Page (4) Problems (3) continued ... FCFS ... Solution Then Around Time (TAT) = WT+BT Tuen A Round Time PLACESS Waiting Time + BustTime 0+4 = 4 P1 4+7 = 11 P2 11+3=14 14+3=17 P4 17+5 = 22 P5 Average Tuen Around Time (ATAT) $ATAT = \frac{4+11+14+17+22}{5} = \frac{68}{5} = 13.60$ = Symof All Then Asound Time Total number of Processes

= 13.60 Millise conds

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Page (5) Numerical Problems on Shortest Job First Scheduling (SJFS) Algorithm (SJF) It is a non preemptive CPU Scheduling Alto lithing Preemptive version of (SJF) & SRTN (Shoutest Remaining Time Next) Problem (1) calculate the Average waiting Time and Average Turn Around Time. Pravide the Gourt Chart. RWST Time PLocess (BT) P1 2 P2 6 23 PA Grantt Chart Step 1. solution: P3 P1 P4

Page 5

Problem on SJF Continued... Page 6 Solution Step 2 wasting Time (WT) Waiting Time Phocess 6 P1 P2 11 P3 **2** PX Average waiting Time = $\frac{6+0+11+2}{4} = \frac{19}{4}$ Averege NT = 4.75 milliseconds Step 3 Averege NT = 4.15 milliseconds Then Around Time Phocess Waiting Time + Busst Time 6+5 = 11 P1 0+2=2 P2 11+6=17 13 2+4=6 11+2+17+6 P4 Arease Then Acound Time = 4 Step4. $=\frac{36}{4}=9$ M8.

borse (C)

Page (7) Mymerical Example on Practity scheduling Alsohitum It is both preemptive and non pheemptive. Each process is assigning on priority number. Phoblem (1) calculate the Averge time for waiting Time, Then Around Time, provide Grantt Chart for the given process that Assive at time O. Busst-Time PRIORITY Process P1 2 P2 6 1 P3 2 P4 Solution Step 1 Gantt Chart Phickity Scheduling for Non-preemptive 10

Pase (7)

Solution on Perocity scheduling continued. Step 2 waiting Time (WT) Process waiting Time PI 10 P2 15 P3 P4 Average Waiting Time = $\frac{10+15+0+6}{4} = \frac{31}{4} = 7.75$ Step 3 Tuen Around Time = Waiting Time + Burg Time. Placess Tuen Around Time P1 10 + 5 = 1515+2=17 0+6=6 14 6 + 4 = 1015+17+6+10 Average Then Around Time = = 48 = 12. millisacondo

Page (p)

Problems on Round Robin Scheduling Algorithm It is a preemptive cpu scheduling Algorithm. Process are siven a limited Amount of Isme of Auceson Called Time Slice (or) Time Quantum. Example 1 Consider the following set of process that Otherive at a trome o, with the length of CPU Bust: Time given in milli se and calculate the Average Watting Time and Averese Then Around Time. Provide Gount chart for the same (Time slice = 2). BUST Time Process BT) P1 P2 2 Gantt chart Solution Step 1 P1 P4 0 12 Step 2 Waiting Time Waiting Time PLOCESS 10 PI 2 Pase(8)

Step on Round Robin scheduling confirmed. Step 2 wasky Time. Process wasting Time P3 11 Average waiting Time = 10+2+11+10_33_8.25 4 millibrans P4 10 Step3 Then Around Time Twen Alound Time = Waiting Time + Busst Firme Tuen Around Time Phocess P1 10+5=15 72 2+2=4 11+6 =17 P3 P4 10+4 = 14

Step 4 Average Then Around Time

ATAT = $\frac{15+4+17+14}{4} = \frac{50}{4} = 12.5$ Millikeconder

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Problems on Shortest Remaining Time First CPU scheduling Algorithm (SRTF It is a Preemptive SJF. In this Alsowthmy the CPU Schedula selects the process with the smallest estimated from time to completion. then new process is admitted to SATF only needs. to compare the currently executing Process with the new phocess, Ignoring all other processes Consently Waiting to execute. Dample 1 Phoblem on (SRTF) Consider the four placess with their Astival Time and BW487 + Prome, Calculate Averge waiting Time, Then Asound time and provide Assival Time BURST Timp Process (AT) (BT) P1 P2

fase (1)

Page (12) Phoblem on SRTF Continued -... Access Aslival Time BWSt time P2 6 P2 13 3 4 14 Gantt Chart Step 1 Solution P1 P4 20 12 Step 3 Average Waiting waiting Time , Time (AWT) PLACESS Waiting Time $\frac{6+0+10+0}{4} = \frac{16}{4}$ 6 P1 = 4 millible conds. 0 P2 10 P3 0 P4 Step 5 Average TAT $= \frac{12+2+18+4}{4}$ $= \frac{36}{4} = 9 \text{ mill sam}$ Tuen Agound Time. Step 9 PLOCES Tuen Around Tempo 6+6=12 P1 2+0=2 P2 8+10-18

Park (1)

Page (13) Problem on SJF (preemptive and Non preemptile): and FCFS. CPU Algorithms. Consider the following set of processory. Example: 1 with the levets of course your firme given in millipleants Assival Time Busst Time Process 13T P1 Drawthe Gantt Chart, Illustrative the execution of these processes using STF (preemptive) and mon preemptive) and FCFS. Colculate Average Than Around Time Aversewaiting Time in each Process. Gantt Chart FCFS solution step 1 10 SJF (Preemptive) Gantt Chart 11

pase (14) Solution of SJF (theemptive and nonpree mptive) and FCFS Continued ... Steps SJF (Non Preemptire) Gantt chati FCFS Then Around Time waiting Time PLACERS BT+ WT 0 PI P2 12 P3 13 10 P4 waiting time= 0+5+7+10=22-5.5 Alregosl Average Then Around Time = 6+9+12+13 $= \frac{40}{4} = 10 \text{ mills }$

Pase (A)

Solution Continued on SIF (preemptive) CL Dun preemptive and FCFs. Step 5 SJF (Preemptive) A Wai Kuf Time Then Albund Time PLOCESS WT + BT 7+6=13 PI 0+4=4 P2 5+10=1510 P3 0+3=3 Avelese war Rug Time = 7+0+10+0=17=4.25 Avegse Tuen Alound Time= 13+4+1573 35 = 2.75 milliteans Dep 6 SJF (non-preemptive) Was KngTime Then Around Time phoces 0+6=6 0 P1 8 + 4 = 12P2 9+5=14 10 P3 1+3=4 Average warry Time= 0+8+4+1 = 19 Average warry Time= 0+8+4+1 = 4=4.75 Average Then Acound Time=G+12+14+4=36=0

page 10 Numerical Example on AFCFS, Boreemptive and hom-preemptive Versions of Shoutest Job First and Round Robin (Time Stice = 2) schedule Algoritums With Gant Chart for the percelses given Below. Calculate their Averese waiting Time and Town Around Time. BURST Time Agriva Time Problem (1) Process 20 10 PI P2 P3 12 3 P4 15 Solution Step 1 (A) Gantt Chart FCFS. P3 P2 P1 43 28 B) Gautt chart for preemptive SJF P3 71 16 28 43 @ Gantt-Chall for Non Preemptive SJF P2 P1 P3 P4 10 16 28

Santt chart for Round Robin (Timeslice = 2) Page (T) P1 P2 P3 P1 P4 P2 P3 P1 P4 P2 P3 P1 P4 P3 P1 P3 P4 P3 P4 P4 P4 P4 P4 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 Waiting Time. PLUCERS FCFS preemptive Non preemptive Round Robin SJF SJF P1 0 \bigcirc 6 20 9 13 P2 22 14 14 14 P3 33 25 25 25 Average Waiting Time FCFS = 0 + 9 + 14 + 25 = 48 = 12

FCFS = 0+9+14+25=48=12Preemptive STF = 6+0+14+25A = 11-25Non Preemptive STF = 0+9+14+25=48=12Round Robin = 20+13+22+33=88=22

fase (7)

Tuen Adound Temme = Waiting Time + Burst Time

F	Mocess	FCFS	Preemptive	Non Preemphire SJF	Round RObin
	PI	10	16	10	30
	P2	15	6	15	19
,	P3	26	26	26	34
	P4	40	40	40	48

Average Than Albund Time

Verale Two Albund Time
$$FCFS = \frac{10+15+26+40}{4} = \frac{91}{4} = 22.75$$

preemptive SJF =
$$16+6+26+40 = \frac{88}{4} = 22$$

Non preemptive
$$SJF = 10+15+26+40 = 91 = 22.75$$

Round Robin RR =
$$\frac{30+19+34+48}{4} = \frac{131}{4} = 35.22$$

Mumerical Example on Priority Alsorithmy Passelly)
and Round Robin Alsorithms

Problem 1 Consider Five processes P1 To P5 are vived at the same Time. They have estimated Running Time 10, 2, 6, 8 and 4 seconds respectively. Their priorities are 3, 2, 5, 4 and 1 respectively. With \$ 5 being highest priority. Find the average waiking Time, Average Than around time for Round Robin (Time Shice 9-3) and priority Scheduling Algorithms.

property so.		م و و ا
Process	Estimated Running Time (BT)	PRIORITY
P1	10	3
72	2	2
P3	6	5
P4	8	4
P5	4	1

pag(20) Solution Step 1 Grantt chart for Round Robbn (Time Slice 8=3) |P2|P3|P4 | P5 |P1 |P3 |P4 |P5 |P1 |P4 |P1 23 Step 2 Gant Chart for Phiohity 2 P1 PA 26 24 step3 Waiting Time Round Robin PRIORity process 14 20 P1 24 3 P2 14 p3 6 21 P4 26 20 Average Waiting Time = 20+3+14+21+20 = 78 Round Robin = 15.60 Milli Donali = 15.60 millideand Page 20

Step 4 Then Albund Time

		20.96
Process	Round Robin	PAROXITY
P1	30	24
P2	5	26
P3	20	6
P4	29	14
P5	24	30

Average Then Akound Time= 30+5+20+29+24

Round Robin = 108 = 21.6 milliseconds

Average Than Akound Time = 21+26+1111+2

Avelage Two Alound Time = 24+26+6+14+30 PHOLITY

 $=\frac{100}{5}=20 \text{ milliferance}$

Avelase Waiking Time = $\frac{14+24+0+6+26}{5}$ Phiohity = $\frac{70}{5}$ = 14 Millistance

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Page (22) Numerical Example DN Cpy scheduling Alsohitum Phiority-preemptive mode-Example 1 Consider the following placesses Find Average Waiting Time, Average Tuen Around time and plovide Gantt chart. Process Arrival Time Busttime Priority (BT) (AT) 3 P2 13 3 P4 6 25 Gantt chart Solutions- Step 1 P1 20



Wasting 7	enne (WT) Passe
Placees	Waiting Terme
P1	5-1 = 4
P2	1-1=0
P 3	2-2=0
P4	12-3=9
P5	14-4=10 4+0+0+9+10
Average l	Jaifing Time = 5
TWN ALOU	= 23 5 Alg Waiting Time = 4.6 Millibeands and time (TAT) = WT+BT
PLucels	Waiting Time + 13 ws) Tem
PI	4+8=12 0+1=1
P3	10+3=3
P4	$\frac{9+2}{10+6=16}$

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Average Then Astund Time = 12+4+3+11+16 == 8.6 mill seands ATAT = Example on Cpy scheduling Algorithm (LRTF) Longest Remaining Time for st Phoblem . Find Average wasking Timme, ThinAsking Time, provide Gant enest: PLUCES ASSIVATIONE BUST TIME **P**1 Gantt chart Solution Step 1 P2 P3 Step2 completion Time, waiting Time, TAT. Tuen Abound Time = Completion Time - A sebual Pine

fall &

rasico Step 3 phicess TAT completion Time 0 CTAT 12 12-0212 0 P2 13-0013 13 14-0214 14 P3 Step4: Avelage Then Award Time= 12+13+14 $=\frac{39}{3}=13$ milli Seands Coutsouthme Numerical Examples hothis material 1. FCFS (First Come First served) 2. Round Robin Scheduling 3 - Shortest Remaining Time FFYST (SRTF)

4. Problity scheduling (preemptive and Non Preemptive

5. Shortest Job First (SJF)

6. Longest Time Remaining FIVSt (LRJF).