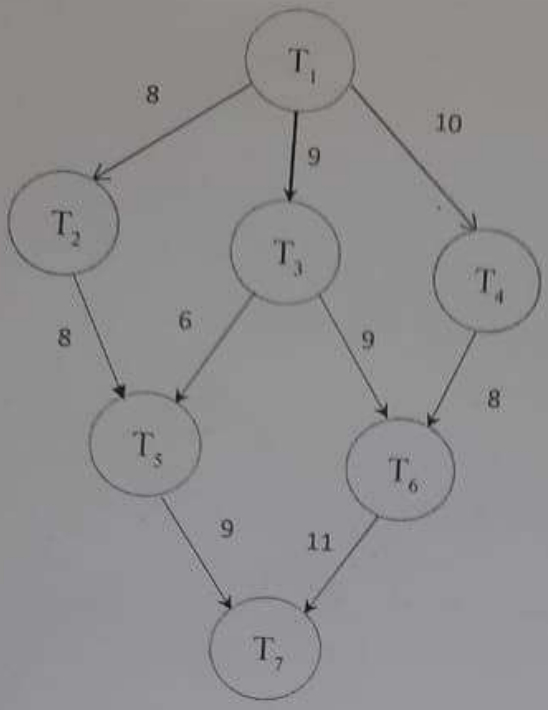

DAG/ workflow

ETC Matrix of 7 tasks against 3 VMs

	VM1	VM2	VM3
T1	7	9	8
T2	10	9	8
T3	6	5	9
T4	9	8	7
T5	6	7	5
T6	7	5	9
T7	8	9	7

Q8. Find the **B-level** Priority value of each tasks. **[1 Marks]**

Q9. Find the **t-level** Priority value of each tasks. **[1 Marks]**

Q10. Generate the overall schedule of all the 7 tasks on available 3 VMs as per the B-level priority value then calculate the ***makespan*** (overall workflow processing time) and ***average VM utilization***. **[2+1+1 Marks]**

Useful Formulas

I. $EST(T_i, VM_j)=0$

II. $$EST(T_i, VM_j) = \max\{ \underset{j \in m\ (VM\ type\ )}{avail\ [j]}\ ,\ \max_{T_p \in pred(T_i)} (AFT(T_i) + TT_{p,i})\}$$

Where, *EST* is the earliest start time of task T_i, T_p is the predecessor tasks set of T_i and $TT_{p,i}$ is the transfer time from T_p to T_i.

III. *EFT* is the earliest finish time which is defined as:

$$EFT(T_i, VM_j) = ACC(Ti) + EST(T_i, VM_j)$$

$$makespan = \min\{EFT\ (Texit\ )\}$$

Ans 8.

	t_1	t_2	t_3	t_4	t_5	t_6	t_7
ACC	8	9	6.66	8	6	7	8

B-level (t_7) = 8 + 0 = 8

B-level (t_6) = 7 + 11 + 8 = 26

B-level (t_5) = 6 + 9 + 8 = 23

B-level (t_4) = 8 + 26 + 8 = 42

B-level (t_3) = $\max \begin{Bmatrix} 6.66 + 6 + 23 \\ 6.66 + 9 + 26 \end{Bmatrix}$ = 41.66

B-level (t_2) = 9 + 8 + 23 = 40

B-level (t_1) = $\max \begin{Bmatrix} 8 + 8 + 40 \\ 8 + 9 + 41.66 \\ 8 + 10 + 42 \end{Bmatrix}$ = ~~56~~ 60

B-level ~~prio~~ priority = $t_1, t_4, t_3, t_2, t_6, t_5, t_7$

ms9

	t_1	t_2	t_3	t_4	t_5	t_6	t_7
ACC	8	9	6.66	8	6	7	8

t level (t_1) = 0

t level (t_2) = 8 + 8 + 0 = 16

t level (t_3) = 8 + 9 + 0 = 17

t level (t_4) = 8 + 10 + 0 = 18

t level (t_5) = $\max \begin{Bmatrix} 9 + 8 + 16 \\ 6.66 + 6 + 17 \end{Bmatrix}$ = 33

t level (t_6) = $\max \begin{Bmatrix} 6.66 + 9 + 17 \\ 8 + 8 + 18 \end{Bmatrix}$ = 34

t level (t_7) = $\max \begin{Bmatrix} 6 + 9 + 33 \\ 7 + 11 + 34 \end{Bmatrix}$ = 52

priority = $t_1, t_2, t_3, t_4, t_5, t_6, t_7$

Ans 10. Priority level :-

$t_1, t_4, t_3, t_2, t_6, t_5, t_7$.

EST (t_1) = $VM_1 = 0$
$VM_2 = 0$
$VM_3 = 0$

EFT (t_1) = i) 0 + 7 = (7) – Best possible
ii) 0 + 9 = 9
iii) 0 + 8 = 8

Assign t_1 to VM_1

EST (t_4) = VM_1 = max (9, 7+0) = 15
VM_2 = max (0, 7+0) = (7)
VM_3 = max (0, 7+8) = 15

EFT (t_4) = i) 15 + 9 = 24
ii) 7 + 8 = (15) Best possible
iii) 15 + 7 = 22

Assign t_4 to VM

$EST(t_4)$ = VM_1 = max(7, 7+0) = 7
VM_2 = max(0, 7+10) = 17
VM_3 = max(0, 7+10) = 17

$EFT(t_4)$ = VM_2 : 7+9 = (16) Best
VM_1 = 17+8 = 25
VM_3 = 17+7 = 24

Assign t_4 to VM_2

$EST(t_3)$ = VM_1 = max(16, 7+0) = 16
VM_2 = max(0, 7+9) = 16
VM_3 = max(0, 7+9) = 16

$EFT(t_3)$ = VM_1 = ~~max~~ 16+6 = 22
VM_2 = 16+5 = (21) Best.
VM_3 = 16+9 = 25

Assign t_3 to VM_2.

$EST(t_2)$ VM_1 = max(16, 7+0) = 16
VM_2 = max(21, 7+8) = 21
VM_3 = max(0, 7+8) = 15

$EFT(t_2)$ VM_1 16+10 = 26
VM_2 21+9 = 30
VM_3 15+8 = (23) Best

Assign t_2 to VM_3.

EST (t_6) $VM_1 = \max \begin{cases} \max(16, 21+9) \\ \max(16, 16+8) \end{cases} = 30$

$VM_2 = \max \begin{cases} \max(21, 21+0) \\ \max(21, 16+8) \end{cases} = 24$

$VM_3 = \max \begin{cases} \max(23, 21+9) \\ \max(23, 16+8) \end{cases} = 30$

EFT (t_6) $VM_1 = 30 + 7 = 37$

$VM_2 = 24 + 5 = (29)$ - Best

$VM_3 = 30 + 9 = 39$

Assign VM_2 to t_6.

EST (t_5) $VM_1 = \max \begin{cases} \max(16, 23+8) \\ \max(16, 21+6) \end{cases} = 31$

$VM_2 = \max \begin{cases} \max(29, 23+8) \\ \max(29, 21) \end{cases} = 31$

$VM_3 = \max \begin{cases} \max(23, 23) \\ \max(23, 21+6) \end{cases} = 27$

EFT (t_5) $VM_1 = 31 + 6 = 37$

$VM_2 = 31 + 7 = 38$

$VM_3 = 27 + 5 = (32)$ Best

Assign VM_3 to t_5

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$EST(t_7) = VM_1 = \max\left\{\begin{matrix}\max(16, 32+9)\\ \max(16, 29+11)\end{matrix}\right\} = 41$

$VM_2 = \max\left\{\begin{matrix}\max(29, 32+9)\\ \max(29, 29+0)\end{matrix}\right\} = 41$

$VM_3 = \max\left\{\begin{matrix}\max(32, 32+0)\\ \max(32, 29+11)\end{matrix}\right\} = 40$

$EFT(t_7) = 41+8 = 49$

$41+9 = 50$

$40+7 = 47$ Best

assign VM_3 to t_7

makespan = 47 overall time.

Utilization $VM_1 = \frac{7+9}{47} \times 100 = 34.04\%$

$VM_2 = \frac{10}{47} \times 100 = 21.27\%$

$VM_3 = \frac{8+5+7}{47} \times 100 = 42.25\%$

Average Utilisation = $\frac{34.04 + 21.27 + 42.25}{3}$

$= 32.62\%$