Question #1 [10 points]

What are the shortcomings of Benefit-Cost Ratio Method?

It is only considering "Ratio" and "Portion" savings, not the "Amount" of dollars.
→ 3 points; magnitude, scale, size are okay
It's only considering the simple net amounts for costs and benefits, not considering discounting factor.
→ 3 points; time factor, duration, schedule are okay
The ratio can be easily manipulated by treating some costs as disbenefit.
→ 3 points
   1 credit for writing anything relevant to the method

Question #2 [10 points]

When there is ambiguity in the contract and disputes arise, you may want to look for manifestations of intent in order to see the intent of the parties. List five common manifestations in the order of priority.

From Higher to Lower Priority;

Express Contract Terms (2)

Course of Performance: on Current Project (2)

Course of Dealing (Course of Action): on Previous Projects (2)

Separately Negotiated Terms: Such as Supplement to the Contract (2)

Customs + Trades of the Industry (Industry Practices) (2)

Question #3 [50 points]

Consider the precedence relationships given in the Table below.

Activity	Predecessors	Durations (weeks)
A	-	9
B	-	5
C	A	3
D	B	10
E	B	6
F	B	8
G	C, D, E	6
H	E	4
I	E, F	3
J	H, I	7

K	G	5
L	J, K	2

Draw AOA (Activity-On-Arrow) diagram. [10 points]

(a) AOA Diagram

Basic Logic = 1
Each Arrow (Activity) = 0.5 * 14 = 7
Correct Start & Finish Nodes = 1 Each * 2 = 2
Unnecessary Dummy = - 0.5

Draw AON (Activity-On-Node) diagram and calculate ES, EF, LS, LF, TF, and FF. Tabulate your answers. Also identify the CPs (Critical Paths). [20 points]

(b) AON Diagram

ES, EF, LS, LF, TF and FF

Activity	ES	EF	LS	LF	TF	FF
Start	1	1	1	1	0	0
A	1	10	4	13	3	0
B	1	6	1	6	0	0
C	10	13	13	16	3	3

D	6	16	6	16	0	0
E	6	12	10	16	4	0
F	6	14	9	17	3	0
G	16	22	16	22	0	0
H	12	16	16	20	4	1
I	14	17	17	20	3	0
J	17	24	20	27	3	3
K	22	27	22	27	0	0
L	27	29	27	29	0	0

Critical Path: (Start) – B – D – G – K - L

ES, EF, LS, LF, TF, FF = 0.25 Each * 72 = 18
Critical Path = 2
(No Table = -1)

Lead-Lag Relationships: Suppose some lead-lag relationships were added to the original relationships given in the table above. Draw the updated AON, calculate ES, EF, LS, LF, TF, and FF, and tabulate your answers. Find the CPs.

Discuss the changes by lead-lag relationships. What are the impacts of the relationships? What are the changes in CP, Duration, and Floats? And what do they mean to management? (The answer doesn't need to be long.)

These newly added relationships are tabulated below. [20 points]

Related Activities	Lead-Lag Relationships
D – G	SS = 8
E – H	FS = 2
E – I	FS = 2
H – J	SS = 3
I – J	FS = 2

(c) AON Diagram

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* Minus Float = "0"

Critical Paths: B – E – I – J – L
B – F – I – J – L

Activity	ES	EF	LS	LF	TF	FF
Start	1	1	1	1	0	0
A	1	10	3	12	2	0
B	1	6	1	6	0	0
C	10	13	12	15	2	1
D	6	16	7	17	1	0
E	6	12	6	12	0	0
F	6	14	6	14	0	0
G	14	20	15	21	1	0
H	14	18	16	20	2	2
I	14	17	14	17	0	0
J	19	26	19	26	0	0
K	20	25	21	26	1	1
L	26	28	26	28	0	0

Discussion

Now there are two critical paths. Duration is reduced by one day mainly by the SS relationship between D and G, which was on CP and allowed concurrent operation. The newly added lead-lag relationships reduced the total floats of other paths making them near critical. This means by slipping one or two days, any other path can become critical. Lead-lag made the project **less flexible**, in overall.

ES, EF, LS, LF, TF, FF = 0.2 Each * 72 = 14.4
Critical Path 0.3 Each * 2 = 0.6
Discussion = 5
(No Table = -1)

Question #4 [30 points]

There are 6 activities (A, B, C, D, E, F) in a project, which are planned to be done within 4 months. Those activities, the times when they are scheduled to be performed, and the costs of the activities are tabulated below.

Activity	Schedule	Costs ($ 1,000)
A	1st Month	600
B	1st Month	800
C	2nd Month	3500
D	3rdMonth	1200
E	3rd Month	1800
F	4th Month	1500

Use the cash flow charts attached to this exam to show the general contractor's cash flow for this project. Assume that the activities will be performed in a linear fashion. Round the numbers to the nearest whole number. There are two different payment conditions; (a) and (b).

The contractor submits his invoice on the last day of the month and gets paid 2 months after the submission. [20 points]

The owner is considering paying one month faster. Also, the owner will hold the 10% retention but only for the first 50% of the project's total worth. What impact will result? [10 points]

Answers:
See the Attached Cash Flow Chart for the Correct Numbers.

Discussion for (b): By receiving payment one month earlier and applying 10% retention only for the first 50% of the project's total worth, the contractor has less interest payment, thus earns bigger profit than in condition (a).

<table>
<tr><td colspan="2"># CASH FLOW (a)</td><td>Note: 20 Working Days/Month</td></tr>
</table>

MONTH

DAY 1

202

403

604

805

1006

1207

140 **TOTAL** A

B

C

D

E

F600

800

3,500

1,200

1,800

1500   DIRECT COST

\+ INDIRECT COST @ $25/working day

\--

TOTAL COST

\+ MARK-UP @ 5%

\--

TOTAL WORTH

- RETENTION @ 10%

    PAYMENT DUE

    PAYMENT RECEIVED

    CUMUL. TOTAL COST
 - CUMUL PAYMENTS
--   CUMUL. (COST-PAY)
 + CUMUL. INTEREST

    OVERDRAFT
 + INTEREST THIS MONTH @ 1%

    CUMUL. O.D. + INT.**(1)** 1400

```
                                                    500
                                      --------------1900
                                                     95
                                      ---------------
                                                   1995
                                                    200
                                      ---------------
                                             (1) 1795

                                               (1) 0

                                                   1900
                                                      0
                                      ---------------
                                                   1900
                                                  (1) 0
                                      ---------------
                                                   1900
                                                     19
                                      --------------1919(1) 3500
                                                            500
                                      --------------4000
                                                    200
                                      ---------------
                                                   4200
                                                    420
                                      ---------------
                                             (1) 3780

                                               (1) 0

                                                   5900
                                                      0
                                      ---------------
                                                   5900
                                                     19
                                      ---------------
                                                   5919
                                                     59
                                      ---------------
                                          5978(1) 3000
                                                    500
                                      --------------3500
```

```
                   175
          --------------
                  3675
                   368
          --------------
          (1) 3307

                 (1) 0

                  9400
                     0
--------------9400
                    78
          --------------
                  9478
                    95
          --------------
9573(1) 1500
                  2000
          --------------
                  2000
                   100
          --------------
                  2100
                   210
          --------------
          (1) 1890

          (1) 1795

                 11400
                  1795
          --------------
                  9605
                   173
          --------------
                  9778
                    98
          --------------
                  9876

          --------------

          --------------

          --------------

          (1) 3780

                 11400
                  5575
          --------------
                  5825
                   271
          --------------
```

```
               6096
                 61
--------------6157

       --------------

       --------------

       --------------


  (1) 3307

              11400
               8882
--------------
               2518
                332
--------------
               2850
                 29
--------------
               2879

       --------------

       --------------

       --------------


  (3) 3087*

              11400
              11969
--------------
               -569
                361
--------------
               -208
                  0
--------------
               9400
               2000
--------------11400
                570
--------------
              11970
               1197
--------------
              10773

              11970
```

```
                                                        11400
                                                        11969
                                                  ---------------
                                                         -569
                                                          361
                                                  ---------------
                                                         -208

                                                  ---------------
```

CASH FLOW (b)	Note: 20 Working Days/Month

MONTH

DAY	1
20	2
40	3
60	4
80	5
100	6
120	7

140**TOTAL**Α

B

C

D

E

F600

800

3,500

1,200

1,800

```
              1500  DIRECT COST                                                500
   +  INDIRECT COST @ $25/working day                           --------------1900
   ---------------------------------------------------------                   95
      TOTAL COST                                                 ---------------
   +  MARK-UP @ 5%                                                             1995
   ---------------------------------------------------------             (1) 200
      TOTAL WORTH                                                ---------------
   -  RETENTION @ 10%                                                         1795
   ---------------------------------------------------------
      PAYMENT DUE                                                          (1) 0

      PAYMENT RECEIVED                                                        1900
                                                                                0
       CUMUL. TOTAL COST                                         ---------------
    -  CUMUL PAYMENTS                                                         1900
   --------------------------------------------------  CUMUL. (COST-PAY)  (1) 0
   +  CUMUL. INTEREST                                             ---------------
   ---------------------------------------------------------                 1900
      OVERDRAFT                                                                19
   +  INTEREST THIS MONTH @ 1%                                   ---------------
   -----------------------------------------------------------          19193500
      CUMUL. O.D. + INT.1400                                                  500
                                                                --------------4000
                                                                              200
                                                                ---------------
                                                                             4200
                                                                      (1) 399*
                                                                ---------------
                                                                             3801

                                                                          (1) 0

                                                                             5900
```

```
                          0
         ---------------
                       5900
                         19
         ---------------
                       5919
                         59
         ---------------
         59783000
                        500
---------------3500
                        175
         ---------------
                       3675
              (1) 0
         ---------------
                       3675

                       1795

                       9400
                       1795
         ---------------
                       7605
                         78
         ---------------
                       7683
                         77
         ---------------
         77601500
                       2000
         ---------------
                       2000
                        100
         ---------------
                       2100
              (1) 0
         ---------------
                       2100

                       3801

                      11400
                       5596
         ---------------
                       5804
                        155
         ---------------
                       5959
                         60
         ---------------
                       6019

         ---------------


         ---------------
```

3675

11400
9271

2129
215

2344
23

2367

----

(1) 2699*

11400
11920

-570
238

-332

```
                                          ---------------
                                                    9400
                                                    2000
---------------11400
                                                     570
                                          ---------------
                                                   11970
                                                    599*
                                          ---------------
                                                   11371

                                                   11970

                                                   11400
                                                   11970
                                          ---------------
                                                    -570
                                                     238
                                          ---------------
                                                    -332

                                          ---------------
```

Discussion = 2