CE167: Engineering Project Management — Fall 2007
Professor William Ibbs

MIDTERM 2 — Date: November 15, 2007

Question 1 [8 points]
An owner and a contractor have a dispute on the specifications of the plumbing materials in the current contract. The contract does not specify the materials required. The dispute arises when the owner requests that the contractor follow specifications used in previous and similar contracts between them. The contractor insists on following the practices of the industry. These two are at odds with each other. As a mediator of this case what would you advise? Why?

I would support the owner [2 points]. The contractor must follow specifications used in the previous and similar contracts. The relative importance of the manifestations of intent states that the **course of dealing** will take precedence over the customs and trade practices of the industry [5 points]. The course of dealing means how the parties have previously dealt with each other prior to entering into the current contract [1 point] (See pages B 297 and B 299).

Question 2 [8 points]
A general contractor drafted and signed a subcontract with a subcontractor for roofing work. Industry trade practices rely on two different roofing specifications from two different manufacturers, namely Bird and Johns-Manville. The roofing work is more expensive under the Bird specifications. Although the subcontract references the roofing specifications, nowhere in the document is it stated which set of specifications is intended. The dispute arises when the general contractor withholds payment from the subcontractor, alleging that the installed roof did not comply with the Bird specifications. The subcontractor used the Johns-Manville specifications. This dispute becomes a lawsuit and goes to court. What would you expect the court to decide? Why?

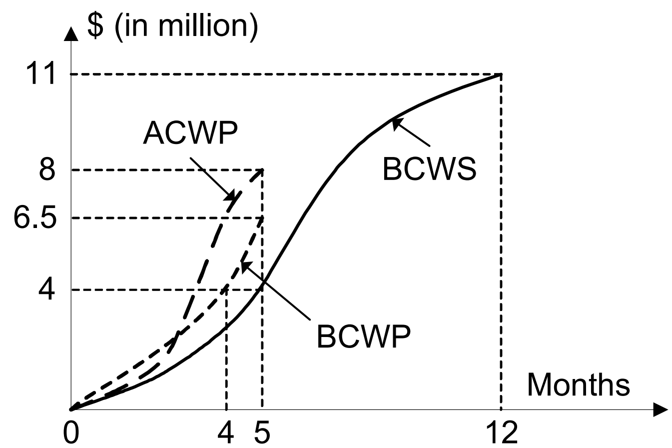
I would expect the court to favor the subcontractor [3 points]. The **doctrine of contra proferentem** requires that the meaning of an ambiguous contract provision be construed against the drafter – the general contractor in this case [5 points].

Question 3 [8 points]
Comment on the cost and schedule status of a project having BCWS, BCWP, and ACWP curves shown in the following figure at i) month 5 and ii) the first five months.

At month 5:
Schedule variance = SV = BCWP – BCWS = 6.5 – 4 = \$2.5mi > 0 [1 point] → The project is ahead of schedule [1 point]. Specifically, the project is approximately 1 month ahead [0.5 point].
Cost variance = CV = BCWP – ACWP = 6.5 – 8 = -\$1.5mi < 0 [1 point] → The project suffers a cost overrun [1 point].

In the first five months:

The fact that BCWP is always greater than BCWS indicates the project has been always ahead of schedule [1.5 point].
BCWP is higher than ACWP in the first months and then less than ACWP thereafter [1 point]. This indicates that the project cost has experienced underrun at the beginning and overrun thereafter [1 points].



Question 4 [22 points]
A 60 million-gallon-per-day (mgd) wastewater treatment plant was built in Pennsylvania in 2004 for a total installed cost of $12.2 million. A similar plant is proposed for California in 2008, though it will have a capacity of 90 mgd. Prepare a preliminary cost estimate considering the following factors:

- The Pennsylvania plant had special site conditions costing $700,000 in 2004 terms.
- The cost capacity ratio for this type of treatment plant is 0.6.
- Inflation has averaged 6% per year.
- Location indexes for PA and CA are 0.91 and 1.12, respectively.
- Unusual equipment is required in the California plant that will cost $850,000 (in 2008 dollars).

[3.5 points] Cost of "normal" 60 mgd wastewater treatment plant in PA in 2004: ${}_{PA}{}^{N}C_{60}^{2004}$ = 12.2-0.7 = $11.5mi
[5 points] Cost of "normal" 90 mgd wastewater treatment plant in PA in 2004: ${}_{PA}{}^{N}C_{90}^{2004} = {}_{PA}{}^{N}C_{60}^{2004}*(90/60)^{0.6} = 11.5*1.2754 =$ $14.67mi
[5 points] Cost of "normal" 90 mgd wastewater treatment plant in PA in 2008: ${}_{PA}{}^{N}C_{90}^{2008} = {}_{PA}{}^{N}C_{90}^{2004}*1.06^{4} = 14.67*1.2625 =$ $18.52mi
[5 points] Cost of "normal" 90 mgd wastewater treatment plant in CA in 2008: ${}_{CA}{}^{N}C_{90}^{2008} = {}_{PA}{}^{N}C_{90}^{2008}*(1.12/0.91) =$ $22.79mi
[3.5 points] Cost of "unusual" 90 mgd wastewater treatment plant in CA in 2008: ${}_{CA}{}^{U}C_{90}^{2008} = {}_{CA}{}^{N}C_{90}^{2008}$ – $0.85mi = 22.79 + 0.85 = **$23.64mi**

Question 5 [21 points]
Your company is preparing a cost estimate for a concrete foundation project in 2008. The volume of ready mixed concrete (2000 psi) to be placed is 1,430 cubic yard. You plan to use a crane and bucket. R.S. Means guidelines indicate that the cost for ready-mixed concrete is $73.50 per cubic yard and the cost for concrete placement is $27.10 per cubic yard, all costs in

year 2004 dollar. The daily output of the concrete placement is 130 cubic yard. Cost escalation rate of ready-mixed concrete has averaged 4% per year. The increase in the cost of concrete placement has averaged 5% for the last few years. The supply of ready mixed concrete is unlimited. The project field overhead is $1,500 per working day. Home office overhead is 10% of project direct cost.

5.a. What is the estimated direct cost of this project? [8 points]

5.b. What is the indirect cost of this project? [7 points]

5.c. If your company decided to have a 15% profit margin on project direct cost, what will be your bid price? [6 points]

5.a. What is the estimated direct cost of this project?

[3 points] Material costs in year 2008 = $73.50x(1 + 0.04)^4 = $85.48/c.y.

[3 point] Placement costs in year 2008 = $27.10x(1 + 0.05)^4 = $32.94/c.y.

[2 points] Estimated direct costs = 1,430x($85.48 + $32.94) = $170,062.5

5.b. What is the indirect cost of this project?

[2 point] The number of project working days = quantity/daily output = 1,430/130 = 11 days.

[2 point] Project field overhead = $1,500x11 = $16,500

[2 point] Home office overhead = $170,062.5x0.1 = $17,006.25

[1 points] Indirect costs = project field overhead + home office overhead = $33,506.25

5.c. If your company decided to have a 15% profit margin on project direct cost, what will be your bid price?

[3 points] Profit margin = $170,062.5x0.15 = $25,509.37

[3 points] Bid price = Direct costs + Indirect costs + Profit margin = $170,062.5 + $33,506.25 + $25,509.37 = $229,078.

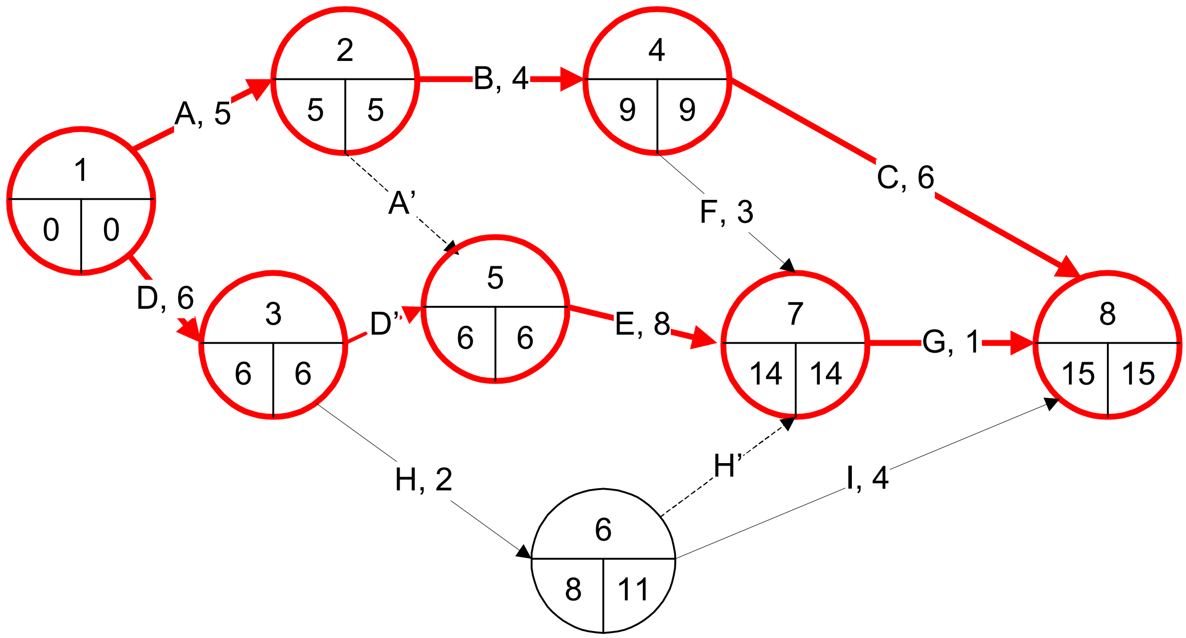
Question 6 [33 points]

Table below defines the activities of a small project

Activity	Duration (day)	Predecessor
A	5	-
B	4	A
C	6	B
D	6	-
E	8	D, A
F	3	B
G	1	E, F, H
H	2	D
I	4	H

6.a. Draw an activity-on-arrow (AOA) network with minimum dummy activities and nodes. Calculate early and late event times. Identify all critical path(s) from this network [10 points].

AON network is below [9 points]

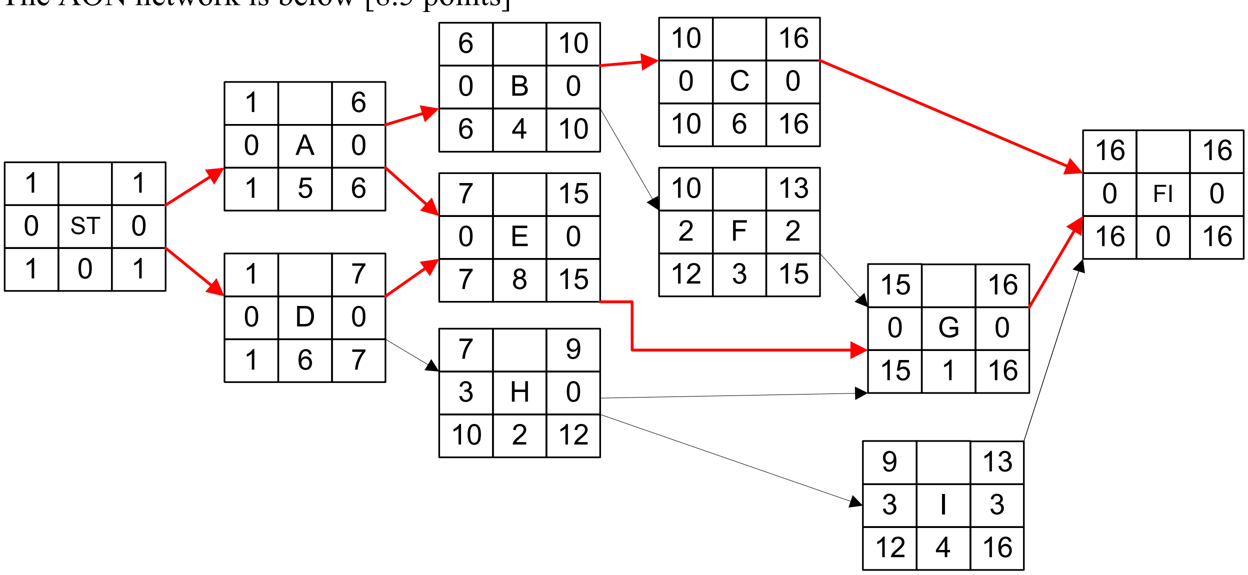


Note: An incorrect network will gain no point. Each additional and/or unnecessary dummy activities or each incorrect early/late event time will be deducted 1 point but total deductions should not be greater than 9 points. The early event time of node 1 can be 1, instead of 0 as shown in the above figure.

Critical paths [1 point]:
A – B – C
D – E – G

6.b. Draw an activity-on-node (AON) network. Calculate ES, EF, LS, LF, TF, and FF of each activities and the project duration. Identify critical path(s) and critical activities. [10 points]

The AON network is below [8.5 points]



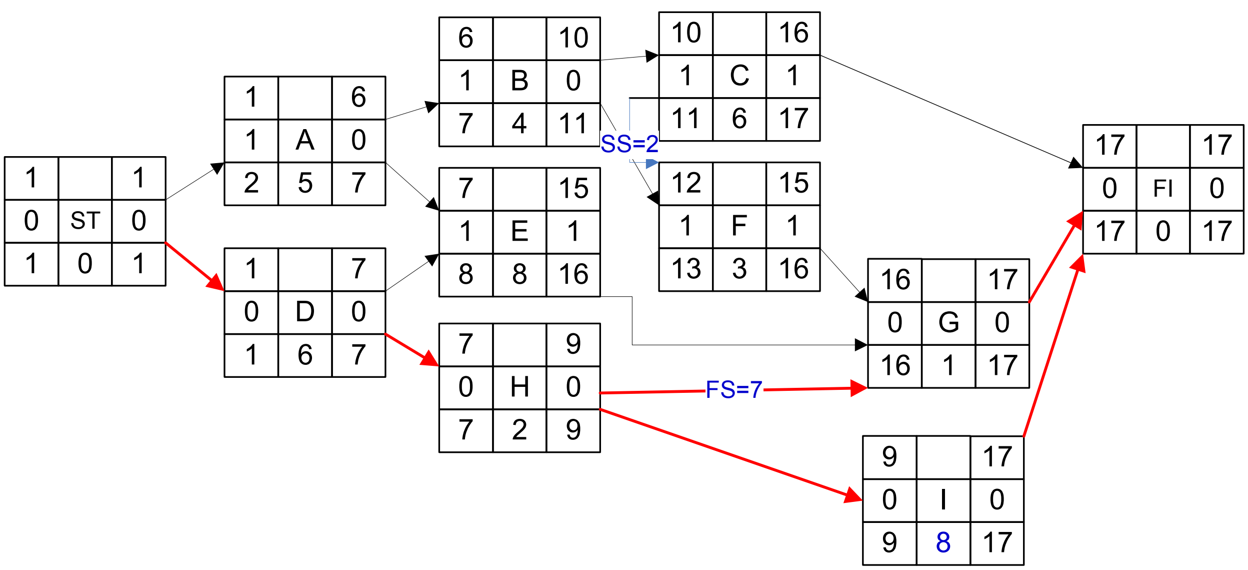
Note: Each wrong relationship or number will be deducted 1 point but total deductions should not greater than 8.5 points.

[0.25 point] Project duration: 15 days
[0.75 point] Two critical paths: A – B – C and D – E – G
[0.5 point] Critical activities: A, B, C, D, E, and G

6.c. Redo question (6.b) given the following additional information: [9 points]

a. C must start two days before F can start (SS = 2).
b. H must finish seven days before G can start (FS = 7).
c. I is delayed four days (the new durations is 8 days).

The new AON network is below [7.5 points]:



Note: Each wrong relationship or number will be deducted 1 point but total deductions should not greater than 7.5 points.

[0.25 point] Project duration: 16 days
[0.75 point] Two critical paths: D – H – G and D – H – I
[0.5 point] Critical activities: D, G, H, and I

6.d. Discuss changes between the network in (6.c) and the one in (6.b) [4 points]
The project duration is increased from 15 days to 16 days. The number of critical activities is less than that of non-critical activities in the new network. Thus, there must be more flexibility in the new network.

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