Multiple Choice Questions - write the letter of your choice on your answer paper

1. Singular Extensions are: [2]
   
   (a) moves which are clearly better than all other moves in a given position and a sequence of such moves is referred to as a singular extension search
   
   (b) states in which the branching factor is 1; thus a singular extension search can exceed the regular depth limit without incurring significant overhead [1]
   
   (c) moves which avoid the “horizon effect” by move ordering them before moves which lead to an ultimately unavoidable damaging move [1/2]
   
   (d) none of the above [0]

2. An advantage of Quiescense Search is: [2]
   
   (a) while it cannot change what move gets selected, it can improve the efficiency of the search by only pursuing non-quiescent moves where large fluctuations in the state eval heuristic value may be expected [1]
   
   (b) it can improve the search efficiency by increasing pruning due to its move ordering effect where non-quiescent moves get ordered before quiescent ones
   
   (c) it can selectively deepen the search depth in order to avoid evaluating the state evaluation heuristic in a non-quiescent state
   
   (d) all of the above [1/2]
   
   (e) none of the above [0]

Regular Questions

The remaining questions are about the following adversarial search tree. State evaluation heuristic values for the max player are provided in the form of numbers following the letter labels of the states (e.g., A4 indicates that the state evaluation heuristic value of state A for the max player is 4). The order in which successors are generated is from left to right. Example: A generates first B, then C, and finally D. Non-quiescent states are indicated by bold circled states.
3. Give the execution trace for HTQSABIDM(A,3,2, −∞, ∞) [HTQSABIDM = History-Table Quiescence-Search Iterative-Deepening Depth-Limited Minimax with Alpha-Beta Pruning]. [27]

#define DLM() HTQSABDLM(), #define Max() HTQSABMaxV(), #define Min() HTQSABMinV()

call    frontier | eval | value          | α, β          | best action, value
------- |-------|----------------|---------------|-------------------
DLM(A,1,2,−∞,∞) | B0C0D0 | MinV(B,0,2,−∞,∞)=12 | 12, ∞         | AB, 12
          | C0D0  | MinV(C,0,2,12,∞)=17 (QS) | 17, ∞         | AC, 17
          | D0    | MinV(D,0,2,17,∞)=1 | 17, ∞         | [AC, 17 [AC:1]]
MinV(C,0,2,12,∞) | G0H0  | MaxV(G,0,1,12,∞)=17 | 12, 17        | CG, 17
          | H0    | MaxV(H,0,1,12,17)=18 (QS, SSS, Prune) | 12, 17  | [HP:1, CG:1]
DLM(A,2,2,−∞,∞) | C1B0D0 | MinV(C,1,2,−∞,∞)=17 | 17, ∞         | AC, 17
          | B0D0  | MinV(B,1,2,17,∞)=14 | 17, ∞         | AC, 17
          | D0    | MinV(D,1,2,17,∞)=3 | 17, ∞         | [AC, 17 [AC:2]]
MinV(C,1,2,−∞,∞) | G1H0  | MaxV(G,0,2,−∞,∞)=17 | −∞, 17       | CG, 17
          | H0    | MaxV(H,0,2,17,∞)=18 (QS, SSS, Prune) | −∞, 17  | CG, 17 [HP:2, CG:2]
MinV(B,1,2,17,∞) | E0F0  | MaxV(E,0,2,17,∞)=14 (QS, SSS, Prune) | 17, ∞   | BE, 14 [EK:1, BE:1]
MinV(D,1,2,17,∞) | I0J0  | MaxV(I,0,2,17,∞)=3 (Prune) | 17, ∞   | DI, 3 [DI:1]
DLM(A,3,2,−∞,∞) | C2B0D0 | MinV(C,2,2,−∞,∞)=17 | 17, ∞         | AC, 17
          | B0D0  | MinV(B,2,2,17,∞)=14 | 17, ∞         | AC, 17
          | D0    | MinV(D,2,2,17,∞)=17 | 17, ∞         | [AC, 17 [AC:3]]
MinV(C,2,2,−∞,∞) | G2H0  | MaxV(G,1,2,−∞,∞)=17 | −∞, 17       | CG, 17
          | H0    | MaxV(H,1,2,17,∞)=18 (SSS, Prune) | −∞, 17  | CG, 17 [HP:3, CG:3]
MaxV(G,1,2,−∞,∞) | N0O0  | MinV(N,0,2,−∞,∞)=17 | 17, ∞         | GN, 17
          | O0    | MinV(O,0,2,17,∞)=4 | 17, ∞         | GN, 17 [GN:1]
MinV(B,2,2,17,∞) | E1F0  | MaxV(E,1,2,17,∞)=14 (SSS, Prune) | 17, ∞  | BE, 14 [EK:2, BE:2]
MinV(D,2,2,17,∞) | I1J0  | MaxV(I,1,2,17,∞)=17 | 17, ∞         | DI, 17 [DI:2]
MaxV(I,1,2,17,∞) | Q0R0  | MinV(Q,0,2,17,∞)=5 | 17, ∞         | IQ, 5
          | R0    | MinV(R,0,2,17,∞)=17 (QS) | 17, ∞   | IR, 17 [IR:1]
MinV(R,0,2,17,∞) | AD0AE0 | MaxV(AD,0,1,17,∞)=17 (Prune) | 17, ∞  | RAD, 17 [R-AD:1]

4. Indicate for each depth iteration of HTQSABIDM(A,3,2,−∞,∞) which nodes, if any, get pruned. [7]

Depth 1: none
Depth 2: F, L, M, J

5. What is the Principal Variant (PV) found by HTQSABIDM(A,3,2,−∞,∞)? [2]
A→C, C→G, G→N