SOFT153

Mathematics Coursework

If you have any queries about this coursework, please direct them to Chris Johnson:
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Please note that this assignment is an individual assignment: you should complete all aspects of this work entirely on your own.

This Maths Coursework accounts for 50% of the module coursework marks.

Learning outcomes assessed: Recognise fundamental mathematical and logical principles that underlie modern computer science.

SUBMISSION REQUIREMENTS

- Your coursework is to be submitted via the DLE by: **12 noon, Monday 14 May, 2018.**
- **PLEASE NOTE** *that your Maths coursework and your Algorithmics coursework are to be submitted via different DLE submission options: please make sure that you submit your Maths coursework via the "Maths Coursework Submission" option.*
- Your submission should consist of a single word (.docx) file which should consist of a completed answer grid. You do **not** need to provide accompanying working.

The ANSWER GRID

- The answer grid is available from the Maths Assignment folder. For each answer you should place an x in precisely one of the 9 options (a, b, c, d, e, f, g, h or "No Answer").
- If you select a, b, c, d, e, f, g or h and your answer is wrong, you will incur a marks penalty: answers chosen *entirely* at random will on average yield a mark of 0.
- Selecting "No Answer" will of course incur no marks penalty.

None of the above

- In some questions, option h is labelled as "None of the above". In this case, option h is the correct answer if and only if a, b, c, d, e, f and g are all false/incorrect.

1. $(x + 1)(x - 2) =$

a. x^2
b. $x^2 + 3$
c. $x^2 + 3x$
d. $3x + 1$
e. $3x$
f. $3x + 2$
g. $x^2 - x - 2$
h. None of the above

2. If $y = (x + 2)/(x + 1)$, then $y-1 =$

a. $2x^2$
b. $x^2 + 3x + 1$
c. $x^2 + 3x$
d. $1 + 2/x$
e. $1/(x+1)$
f. $1/3x$
g. $x^2 + 1/3x$
h. None of the above

3. $x^{-1} + (x/2)^{-2} =$

a. $5x^{2.5}/4$
b. $(x^3 + 4)/x^2$
c. $\sqrt{x} + x^2$
d. $x^2/4$
e. $(x + 4)/x^2$
f. $(x + 2)/x^2$
g. $(x + 4)/\sqrt{x}$
h. None of the above

4. $\ln(2^y e^{y/x}) =$

a. $x + 2\ln(y)$
b. $\ln(x) + (y+x)\ln(2)$
c. $y(1 + x\ln(2))/x$
d. $y\ln(x)$
e. y^2/x
f. $y\ln(2)/x$
g. $y(\ln(2) + 1)/x$
h. None of the above

5. $e^{\ln(2) + \ln(x*y)} =$

a. $x + e$
b. xy/e^2
c. $2xy$
d. $-2 + xy$
e. $2xy/e$
f. $xy/2$
g. $2+xy$
h None of the above

6. Suppose that the function f is defined by the equation $f(x) = x/(x+\sqrt{x})$, and suppose also that as $x \to \infty$, $f(x) \to \alpha$. What is the value of α?

a. 0
b. 1/2
c. $1/\sqrt{2}$
d. $1/(1+\sqrt{2})$
e. 1
f. $\sqrt{2}$
g. ∞
h None of the above

7. Suppose that the function f is defined by the equation $f(x) = x/(x^2+1)$, and suppose also that as $x \to \infty$, $f(x) \to \alpha$. What is the value of α?

a. 0
b. 1/2
c. $1/\sqrt{2}$
d. $1/(1+\sqrt{2})$
e. 1
f. $\sqrt{2}$
g. ∞
h. None of the above

8. Suppose that the function f is defined by the equation $f(x) = e^x/(4e^x + x^2)$, and suppose also that as $x \to \infty$, $f(x) \to \alpha$. What is the value of α?

a. 0
b. 1/2
c. $1/\sqrt{2}$
d. 1/4
e. 1
f. 2
g. ∞
h. None of the above

9. Suppose that the function f is defined by the equation $f(x) = (x-4)^2 - 4$. Which of the following statements is true?

i. The slope of $y = f(x)$ is always > 0 when $x > 0$
ii. The slope of $y = f(x)$ increases as $x \to \infty$
iii. The slope of $y = f(x)$ increases as $x \to -\infty$
iv. The slope of $y = f(x)$ is < 0 when $x < 0$
v. The slope of $y = f(x)$ is never 0

a. i and iii only
b. i, iii and iv only
c. ii, iii and v only
d. ii, iii, iv and v only
e. ii and iv only
f. ii, iv and v only
g. i, iv and v only
h. None of the above

10. A commonly cited formula for computing the (nominal) calendar time (in months) **TDEV** required to complete a software development project is $\mathbf{TDEV} = 3 * \mathbf{PM}^{0.33}$ where **PM** is the effort estimate in person-months. If we have estimated that PM = 360, then which of the following would be a reasonable estimate for TDEV (in months)?

a. 17
b. 21
c. 13
d. 23
e. 19
f. 15
g. 25
h. 11

11. A commonly cited formula for computing the (nominal) calendar time (in months) **TDEV** required to complete a software development project is $\mathbf{TDEV} = 3 * \mathbf{PM}^{0.33}$ where **PM** is the effort estimate in person-months. If we have estimated that PM = 360, then which of the following would be a reasonable estimate for the minimum possible delivery schedule (in months)?

a. 8
b. 10
c. 12
d. 14
e. 16
f. 18
g. 20
h. 22

Questions 12-14 refer to the Doty model which states that the (estimated) effort **PM** to develop a software system is given by the formula: $PM = 5.288 * KLOC^{1.047}$ where KLOC is the (estimated) number of thousands of lines of code.

12. What is the value of PM (according to the Doty model) if KLOC = 15?

a. 90
b. 77
c. 82
d. 84
e. 67
f. 97
g. 102
h. 107

13. What is the value of PM (according to the Doty model) if KLOC = 45?

a. 214
b. 285
c. 262
d. 351
e. 281
f. 333
g. 335
h. 297

14. Two project managers, Alan and Fred, are about to commence work on separate software development projects. Alan has noted that the estimated lines of code for his project is three times that of Fred's project. What does the Doty model suggest would be the difference between the effort required in Alan's project vs. that in Fred's? Alan's would be:

a. 6.8 times higher
b. 3.8 times higher
c. 3.2 times higher
d. 4.3 times higher
e. 5.5 times higher
f. 6.1 times higher
g. 6.4 times higher
h. 5.3 times higher

15. Suppose that we intend to develop a small software system. The total cost of the allocated staff is £15K per month and we estimate that the project will require 9 months. There is one risk with probability of occurrence = 0.3; the schedule impact of the risk would be a delay of 4 months. Assuming that there are no other factors to be considered, and that the estimates are indeed correct, what is the expected cost?

a. £196K
b. £140K
c. £166K
d. £172K
e. £153K
f. £135K
g. £159K
h. None of the above

16. Suppose that we intend to develop a small software system. The total cost of the allocated staff is £20K per month and we estimate that the project will require 11 months. There are two risks R1 and R2.

- If both R1 and R2 occur then there is a schedule impact of 6 months extra work for the project team. The probability of this occurring is 0.4.
- If neither R1 nor R2 occur then there is no schedule impact for the project team. The probability of this occurring is 0.2.
- If either R1 or R2 occurs without the other then there is a schedule impact of 4 months extra work for the project team.

What is the expected cost of the project?

a. £212K
b. £240K
c. £288K
d. £330K
e. £230K
f. £300K
g. £405K
h. None of the above

17. Suppose we intend to develop a small software system. The total cost of the allocated staff is £20K per month and we estimate that the project will require 10 months. There are two risks R1 and R2 whose occurrences are independent; they have probabilities 0.3 and 0.2 respectively. If R1 occurs, the project incurs a penalty of £30K; if R2 occurs, the project incurs a penalty of £55K. The penalties are also independent meaning that if both risks occur, then both penalties apply. What is the expected cost?

a. £220K
b. £245K
c. £620K
d. £155K
e. £275K
f. £420K
g. £320K
h. None of the above

18. Suppose that we randomly pick a card from a standard pack of 52 playing cards (containing 13 hearts; 13 diamonds; 13 spades; 13 clubs). What is the probability that we pick a queen or a king?

a. 13/52
b. 2/13
c. 17/52
d. 4/13
e. 1/3
f. ½
g. ¼
h. None of the above

19. Suppose that we take a standard pack of 52 playing cards, and then remove all four aces and two of the queens. Suppose now that we randomly pick a card from the remaining pack. What is the probability of picking either a queen or a king?

a. 3/10
b. 25/48
c. 13/24
d. 9/25
e. 3/23
f. 8/46
g. 2/13
h. None of the above

20. Suppose that we take a standard pack of 52 playing cards, and then remove all four aces and the queen of spades and the six of hearts. Suppose now that we randomly pick a card from the remaining pack. What is the (conditional) probability that the card is a 6 or a 7 given that it is a red card (i.e., a diamond or a heart)?

a. 4/25
b. 3/13
c. 1/4
d. 2/11
e. 5/11
f. 3/13
g. 3/23
h. None of the above

Questions 21-22 refer to a class of 60 students which is comprised of UK and overseas students as follows.

	UK	**Overseas**
Male	22	13
Female	16	9

21. If we take a student at random from the class, what is the probability of picking a UK student?

a. 4/10
b. 4/35
c. 35/60
d. 7/16
e. 9/35
f. 22/38
g. 7/25
h. None of the above

22. **W**hat is the conditional probability that a male student chosen randomly from the class is from the UK?

a. 4/10
b. 4/35
c. 35/80
d. 7/16
e. 22/35
f. 21/32
g. 7/25
h. None of the above

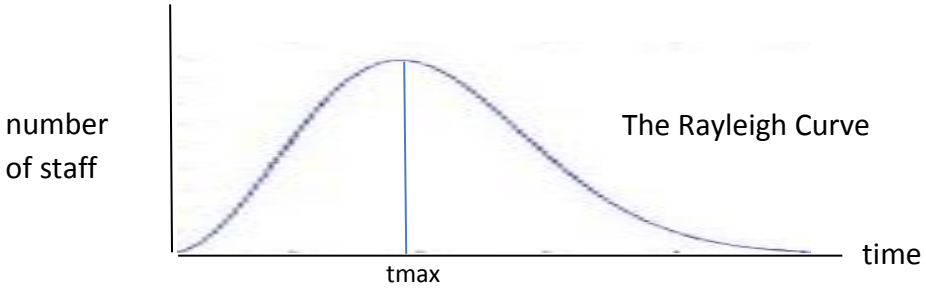
23. A class of students is 40% male; 60% female. The class has 30% students from the UK, the rest being from overseas. In a maths exercise the students have computed that the conditional probability of a UK student chosen randomly from the class being male is 0.6. What is the conditional probability that a male student chosen randomly from the class is from the UK?

a. 0.24
b. 0.45
c. 0.35
d. 0.2
e. 0.55
f. 0.72
g. 0.18
h. None of the above

24. Suppose we have a class of students from the UK and overseas as depicted in the table below. You are told – choosing students at random – that picking a UK student and picking a Male student are independent events. How many students in the class altogether?

	UK	**Overseas**
Male	24	15
Female	16	?

a. 65
b. 60
c. 62
d. 66
e. 68
f. 72
g. 70
h. None of the above



Questions 25-28 refer to the Rayleigh curve shown above: this is often used to model the number of staff required to develop & maintain a large software system. It dictates that the approximate number of staff p required at time t is given by the formula $p(t) = 2Kate^{xp(-at^2)}$ where delivery of the software occurs at the peak: $tmax = 1/\sqrt{(2a)}$. Let f(t) be the function $f(t) = -K * exp(-at^2)$, then you are given that the derivative of f(t) is $f'(t) = p(t)$.

25. Which of the following expressions is equal to the total effort required *after* delivery of the software?

a. K
b. K * 2 * exp(-1/2)/3
c. K * (1 – exp(-9/32))
d. K * exp(-1/2)
e. K * (1 – exp(-1/2))
f. K * exp(1/2)
g. K * (1 + exp(1/2))
h. None of the above

Suppose our proposed software development is estimated to require 400 person-months.

26. Using the formula given in Question 10, what is your estimate for the value of a?

a. 0.002
b. 0.005
c. 0.006
d. 0.007
e. 0.009
f. 0.001
g. 0.003
h. 0.004

27. What is your estimate for the value of K?

a. 1000
b. 1205
c. 906
d. 1107
e. 862
f. 1097
g. 1153
h. 815

28. What is your estimate for the value of p (the number of staff) at the peak?

a. 19
b. 22
c. 25
d. 28
e. 31
f. 34
g. 37
h. 40

Questions 29-32 refer to the following tasks & interdependencies that exist within a project.

Task	Duration (weeks)	Dependencies
T1	2	
T2	3	
T3	6	
T4	3	
T5	7	T2
T6	4	T1, T4
T7	5	T3, T2
T8	3	T4, T5
T9	2	T7, T8

So, for example, T6 cannot start until both T1 and T4 have completed. We assume that the project starts in "week 0".

29. Which is the critical path through the activity network?

a. T1, T6
b. T1, T2, T3, T6, T8
c. T2, T5, T8, T9
d. T2, T4, T5, T8, T9
e. T2, T4, T5, T6, T8, T9
f. T3, T7, T9
g. T3, T4, T8, T9
h. None of the above

30. What is the length of the critical path (in weeks)?

a. 11
b. 12
c. 13
d. 14
e. 15
f. 16
g. 17
h None of the above

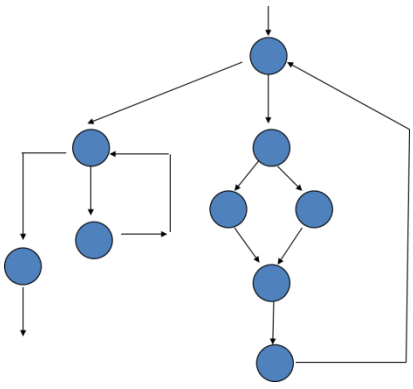
31. What is the latest start date for task T4 (in weeks)?

a. 0
b. 1
c. 2
d. 3
e. 4
f. 5
g. 6
h. None of the above

32. What is the slack of task T7 (in weeks)?

a. 0
b. 1
c. 2
d. 3
e. 4
f. 5
g. 6
h. None of the above

33. What is the cyclomatic complexity of a block of code whose program flowgraph is depicted blow?



a. 0
b. 1
c. 2
d. 3
e. 4
f. 5
g. 6
h. None of the above

34. What is the cyclomatic complexity of the following block of code?

```
A := A-2;
B := B-1;
```

a. 0
b. 1
c. 2
d. 3
e. 4
f. 5
g. 6
h. None of the above

35. What is the cyclomatic complexity of the following block of code?

```
if A > 0 then
        A := A-2
else
        while A > 0 do B := B-1
```

a. 0
b. 1
c. 2
d. 3
e. 4
f. 5
g. 6
h None of the above

36. What is the cyclomatic complexity of the following block of code?

```
A := A-2;
while A > 0 do
        if B>0 then
                begin
                        B := B-1;
                        while C>0 do C:=C-B
                end-if;
```

a. 0
b. 1
c. 2
d. 3
e. 4
f. 5
g. 6
h. None of the above

37. Which of the following propositional formulae is a logical consequence of the formula $(p \vee q) \wedge (q \rightarrow \neg r) \wedge \neg(\neg r \wedge \neg p \wedge s)$?

a. $r \rightarrow \neg p$
b. $s \rightarrow p$
c. $p \rightarrow q$
d. $p \rightarrow \neg r$
e. $q \rightarrow p$
f. $\neg p \rightarrow s$
g. $p \rightarrow r$
h. None of the above

38. Which of the following propositional formulae is *not* a tautology?

a. $p \rightarrow (p \vee r)$
b. $p \wedge r \rightarrow r$
c. $(p \rightarrow q) \wedge \neg q \wedge (\neg r \rightarrow p) \rightarrow r$
d. $((\neg p \vee q) \wedge (\neg q \vee \neg r)) \rightarrow (p \rightarrow \neg r)$
e. $(q \rightarrow p) \rightarrow (\neg p \vee q)$
f. $(\neg p \rightarrow q) \rightarrow (p \vee q)$
g. $(\neg p \vee q) \leftrightarrow \neg(p \wedge \neg q)$
h. None of the above

39. Which assignment of truth values to the formula below renders the formula false?

$$((p \vee q) \wedge (\neg q \vee r)) \rightarrow (p \rightarrow r)$$

a. p=q=r=TRUE
b. p=q=TRUE and r=FALSE
c. p=TRUE and q=r=FALSE
d. p=FALSE and q=r=TRUE
e. p=r=FALSE and q=TRUE
f. p=q=FALSE and r=TRUE
g. p=q=r=FALSE
h. None of the above

40. The *Logarithmic Poisson execution time model* dictates that the rate of software failure [failures per second of execution time] f(t) is related to the time t spent executing the code during testing via the formula $f(t) = f_0/(f_0pt+1)$.

A project manager is attempting to use this model in order to estimate how much (execution) time is required during testing in order to reach the required level of reliability. To-date 4 measurements of failure rate have been taken as given in the table below and from this data the values of f_0 and p have been estimated as f_0=0.02 and p=8.

t (seconds)	measured failure rate (failures per second)	$f_0 / (f_0pt + 1)$
4	0.0114	0.0122
10	0.0081	0.0077
16	0.0051	0.0056
22	0.0046	0.0044

Using this model, how much execution time (in seconds) is required during testing in order to reach the given level of failure rate of at most 0.001 failures per seconds?

a. 101
b. 112
c. 108
d. 119
e. 135
f. 154
g. 166
h. 179

THE END