

Instructions: (70 points) This exam has 10 questions distributed over 4 pages. Solve each of the problem and box in your final `\answer`, where applicable.

- (2^{pts}_{ea.}) 1. Answer each of the following, none of the problems shown below requires any calculations. Respond to True/False questions with T (for True) or F (for False).
- (a) When viewing the graph of a function, we may use the _____ Test to determine if it is a one-to-one function.
- (b) _____ (T or F) The graph of the function $f(x) = 2 - 4x - 3x^2$ is a parabola that opens up.
- (c) _____ (T or F) For a quadratic function of the form $f(x) = ax^2 + bx + c$, if $a > 0$, then the function has a *maximum value*.

Comments: Questions like the three above (fill-in and True/False) often have no solution; hence, normally, the `solution` environment is not used. When using the `vspacewithsolns` or the `solutionsonly` options you would like the “answers” to appear on the solutions pages. To rectify this, we simply copy and past the item into a solutions environment, like so, in the case of the last question above.

```
\begin{solution}[]\ifvspacewithsolns
\TF{F} (\texttt{T} or \texttt{F}) For a quadratic function of the form
    $f(x)=ax^2+bx+c$, if $a>0$, then the function has a \emph{maximum
    value}.\fi
\end{solution}
```

The optional argument is empty (important). We don't want the student or instructor to see this solution when the document is compiled using the `answerkey` option, so we wrap this solution in a conditional `\ifvspacewithsolns... \fi` This switch will be true if either the options `vspacewithsolns` or `solutionsonly` options are taken

- (d) Which rational function below has a horizontal asymptote of $y = -2$, and has vertical asymptotes of $x = 1$ (odd) and $x = 2$ (even)?

| | | |
|---|---|---|
| <input type="checkbox"/> A $y = \frac{(x+2)(1-2x)}{(1-x)(x-2)^2}$ | <input type="checkbox"/> B $y = \frac{(x+2)^2(2x-1)}{(x-1)(x-2)^2}$ | <input type="checkbox"/> C $y = \frac{(x+2)^2(1-2x)}{(x-1)(x-2)^2}$ |
| <input type="checkbox"/> D $y = \frac{(x+2)^2(2x-1)}{(x-1)^2(x-2)}$ | <input type="checkbox"/> E $y = \frac{(x+2)(1-2x)^2}{(x-1)^2(x-2)}$ | <input type="checkbox"/> F none of these |

Comments: Multiple choice and multiple selection questions were an especially difficult problem to solve; the `answers` and `manswers` environments are undefined outside of an `exam` environment so one cannot simply copy and paste the choices into the `solution` environment.

To resolve this issue, I added a key-value pair to the `\bChoices` command, the key is `label`. The source code for the above question reads `\bChoices[label=whichRat]` The value of the label key is used to build a series of macros that record the labels and text for the choices that are marked correct by `\Ans1`. The information gathered by these macros are accessible through `\useSavedAlts`, `\useSavedAns`, `\useSavedAltsAns`, and `\useSavedNumAns`, as described in the `eqexam` manual. See the solutions pages to see the answers to these multiple choice questions and details on the use of these commands.

- (e) How many times can a quadratic equation cross the x -axis? Check as many of the alternatives that are possibly correct for a quadratic function.

| | | | |
|------------------------------|------------------------------|--|--|
| <input type="checkbox"/> A 0 | <input type="checkbox"/> B 2 | <input type="checkbox"/> C 3 | <input type="checkbox"/> D 4 |
| <input type="checkbox"/> E 5 | <input type="checkbox"/> F 6 | <input type="checkbox"/> G infinitely many | <input type="checkbox"/> H none of these |

Comments: The above question is a multiple selection question. The student must select all the correct choices. See the solutions pages to see the answers to these multiple choice questions and details on the use of these commands.

(5^{pts}) 2. Which rational function below has a horizontal asymptote of $y = -2$, and has vertical asymptotes of $x = 1$ (odd) and $x = 2$ (even)?

A $y = \frac{(x + 2)(1 - 2x)}{(1 - x)(x - 2)^2}$

B $y = \frac{(x + 2)^2(2x - 1)}{(x - 1)(x - 2)^2}$

C $y = \frac{(x + 2)^2(1 - 2x)}{(x - 1)(x - 2)^2}$

D $y = \frac{(x + 2)^2(2x - 1)}{(x - 1)^2(x - 2)}$

E $y = \frac{(x + 2)(1 - 2x)^2}{(x - 1)^2(x - 2)}$

F none of these

Comments: This is the same question as Problem 1 (d), but this one is a stand alone question. The lettering of the label can change depending on the options you take, so, if you compile this document without the `useforms` options, the choices listed in 1 (d) will be numbers, (A), (B), . . . , and the choices of this question will be letters, (a), (b), Check the solutions page, the references should change to reflect the change in options, let's hope.

(10^{pts}) 3. Let $f(x) = 4x + 3$ and $g(x) = 2x^2 - 5$. Compute each of the following, simplify were appropriate.

(a) (2 pts) $(fg)(-2) =$

(c) (2 pts) $(f \circ f)(x) =$

(b) (2 pts) $\left(\frac{g}{f}\right)(x) =$

(d) (4 pts) $(f \circ g)(x) =$

Comments: Nothing new about the above problem, each has a solution, no special attention is needed. In some of the answer boxes, `\ifNoSolutions` is used to set the width then `nosolutions` is in effect, and to et the box to its natural width otherwise.

(5^{pts}) 4. Use the **vertex formula** to find the x -coordinate, h , and the y -coordinate, k , of the quadratic function $f(x) = 2x^2 - 8x + 5$.

$h =$

$k =$

5. (3 pts) The function $f(x) = x^2 - x + 1$ has a _____ (max/min) at $x =$ _____.

Comments: I include this problem in this file, because it is a construct that appeared in a test of mine. I wanted to conserve vertical space so I put to problems into two column format. The problem is the points appear to the left. So, for the problem on the left, the points appear as usual, for the problem on the right, the points appear in-line, I had to explicitly increment the points counter, like so `\addtocounter{eqpointvalue}{3}`. Some adjustment of the space between the columns was necessary `\setlength{\columnsep}{30pt}`.

- (5^{pts}) 6. For a polynomial of degree 12, according to theory, the maximum number of zeros is _____, and the maximum number of turning points is _____.

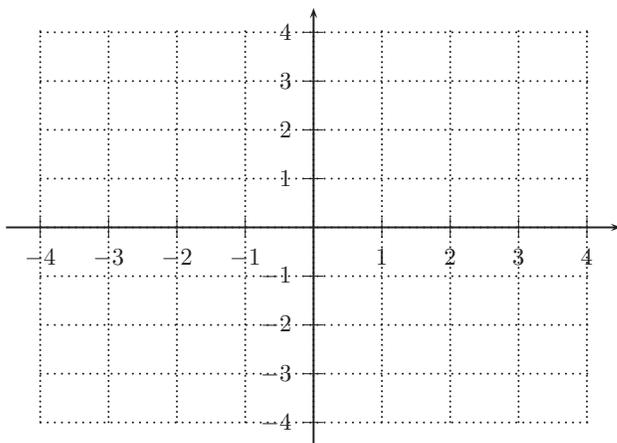
Comments: A fill-in the blank problem, just copy and paste it into the solution environment, protected by `\ifvspacewithsolns... \fi`.

- (5^{pts}) 7. In the boxes provided, list the laws of the exponents and the laws of logarithms.

| | |
|------------------------------|---------------------------|
| Laws of the Exponents | Laws of Logarithms |
|------------------------------|---------------------------|

Comments: The above pair of boxes use the `enclosesoln` key. When this key is used, the vertical size of the box is adjusted to the vertical size the solution uses when either `nosolutions` or `vspacewithsolns` option are used. Note the dimensions of the `\parbox` are adjusted so that the width and height are correct. The `\boxed` command adds `2\fbboxesp+2\fbboxrule`, so we reduce the `\parbox` by that amount so the boxes are the correct size.

- (12^{pts}) 8. Define $f(x) = -2x^2(x + 1)$. Make a good sketch of the graph in the coordinate plane below, taking into consideration the end-behavior of the polynomial, and its intercepts.



Work Area

Comments: Finally, we have the above problem. It uses the `workarea` environment. Previously, `workarea` appeared with the `nosolutions` option. Now it appears with the `vspacewithsolns` option as well. On the actual test, I used `PSTricks` for the graphics, for this demo file, I replace the `pstricks` code this a figure depicting what the `pstricks` produced, that way users of `pdflatex` can compile this file! :-)

On this page, we more clearly demonstrate the new feature of preserving the vertical space even when the `answerkey` option is used. In the preamble, we have `\vspacewithkeyOn`.

(10^{pts}) **9.** Solve the equation $2x^2 - 5x + 10 = 0$ using the quadratic formula.

(5^{pts}) **10.** Write the equation, in standard form, for the circle with center at $C(1, -3)$ and radius of 2

Comments: The `solution` environments in the above problems declared 4 inches and 1 inch of vertical space, respectively. With `\vspacewithkeyOn` we should have about 4 inches (resp., 1 inch) of vertical space even with the `answerkey` option. Try compiling the file with `\vspacewithkeyOff`.