USAAVNS PT 13

PROGRAMED TEXT

NAVIGATIONAL COMPUTER

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UNITED STATES ARMY AVIATION SCHOOL
FORT RUCKER, ALABAMA

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UNITED STATES ARMY AVIATION SCHOOL
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PROGRAMED TEXT

TITLE: MB-4 NAVIGATIONAL COMPUTER

SCOPE: Method of using the navigational computer to solve the following types of navigational problems: Airspeed, Altitude, Time-Rate-Distance, Fuel and Wind Solutions.

INSTRUCTOR REFERENCES: TM 1-225

MATERIALS ISSUED TO STUDENTS: MB-4 COMPUTER

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CONTENTS

PREFACE

This program will require an MB-4 Navigational Computer to be used as you read through the program. Information will be presented to you so that you may learn at your best rate of speed. Only those basic aspects of the computer which are needed by Army Aviators to solve navigational problems will be covered in this program.

OBJECTIVES

MB-4 COMPUTER

PROGRAM OBJECTIVES

Using the MB-4 computer (computer side), you will be able to solve the following types of problems. 90% of the problems should be solved correctly.

1. Identify the indices and reference points on the computer face when given a picture of the computer.

2. Mileage and speed conversions.

   a. Given: Statute miles.

      Solve for: Nautical miles and kilometers (KM).

   b. Given: Nautical miles.

      Solve for: Statute miles and KM.

   c. Given: KM.

      Solve for: Statute and nautical miles.

3. Time, rate, and distance.

   a. Given: Time and rate.

      Solve for: Distance.

   b. Given: Rate and distance.

      Solve for: Time.

   c. Given: Distance and time.

      Solve for: Rate.

4. Altitude correction.

   Given: Indicated altitude and temperature.

   Solve for: True Altitude.

5. Airspeed Corrections.

   a. Given: Indicated airspeed, temperature and altitude.

      Solve for: True airspeed.

   b. Given: True airspeed, temperature and altitude.

      Solve for: Indicated airspeed.

   c. Given: Pressure altitude and temperature.

      Solve for: Density altitude.

6. Using the wind face side of the computer solve the following types of problems.

   a. Given: Wind, airspeed and course.

      Solve for: Heading and groundspeed.

   b. Given: Wind, groundspeed, and course.

      Solve for: True heading (TH) and True airspeed (TAS).

   c. Given: True heading, course and true airspeed.

      Solve for: Wind.

DIRECTIONS FOR USE OF PROGRAMED TEXT

This is not a regular book; therefore, you must follow the directions in order to use it correctly. Each page is divided into three separate sections - or frames. Page numbers are at the bottom center of a page. Each frame is numbered in the upper right corner of the frame. You will begin by reading frame 1 at top of page 1, then continue to frame 2 at top of page two. DO NOT TRY TO READ DOWN THE PAGE - it won't work. Most of the time each frame will require you to answer a question or solve a problem. Write your answers on the sheets provided - then look on the back of the frame to check the correct answer. NOTE: A small tolerance in the answers will be acceptable due to the difference in computers.

Allowable tolerances: Speeds ± 3 knots

Distance ± 3 miles

Time ± 2 minutes

Wind ± 7°/2 knots

Altitude ± 300 feet

BEGINNING STUDENT: Start on page 1 frame 1.

ADVANCED STUDENT: Start on page vii.

DIRECTIONS FOR ADVANCED STUDENTS

This program may be used as a computer review by working the test only. If you fail to obtain 90% on any test you should work through the program for that particular section.

Work the test on the following pages.

SECTION I Frame 1

Remove the sliding card from the computer and lay it aside for now, you will cover it later. Now look at your computer, the computer side has the movable disc and two circular scales. The other side has a transparent disc located within a compass rose. This side is called the Wind face side or Grid side. First you should study the Computer Side. Go to page 2 frame 2.

Frame 7

Since you found that 100 nautical miles is equal to 115 statute miles and 184 kilometers, now determine that 100 statute miles is equal to 87 nautical and 160 KM.

Frame 13

Without changing the computer set-up you can read the poundage for any given number of gallons. For example 25 gallons will weigh:

a. 15 See page 2 frame 14.

(b) 150 See page 5 frame 17.

(c) 42 See page 3 frame 15.

d. 420 See page 4 frame 16.

Ans: 87 nm 160 km

Frame 2

A diagram of the computer is shown on page 43. Fold out this page for future reference as you progress through this booklet. See figure 1 page 43. Study this picture a few minutes. The nautical, statute and kilometer indexes are located on the _____ scale. The speed and "sec" indexes are on the _____ scale.

(inner-outer)

Frame 8

Now convert 100 KM to statute and nautical. By placing the "10" under the KM index you read 62.5 statute and 54 nautical miles.

Your answer was 15. Frame 14

This is not a logical answer if one gallon weighs 6 pounds, 2 gal weighs 12 and 3 weighs 18, therefore 15 could not possibly be correct. The number 15 can represent .15, 1.5, 15.0 or even 15000. Return to page 1 and select another choice.

Ans: Outer

Inner

Ans: 62.5 stat.

54 Naut.

Frame 3

The black triangle reference point on the moveable scale is called the speed index index.

Frame 9

If you set 90 under the "Naut" index you read 103.5 stat mile under the "Stat" and 166 KM under the KM.

Frame 15

Your answer: c. 42

No, don't change the system of reading the answer. Pounds is set-up on the outer scale and gal. on the inner scale. Return to page 6 frame 12 and review this, then go to page 1 and answer it correctly.

Ans: Speed or rate

Ans: 104 stat.

166 km

Frame 4

Move the inner disc so that the "10" aligns with the "10" on the outer scale. Do all of the numbers align on the two scales?

(yes - no)

Frame 10

Using the computer you find that 280 nautical miles is equivalent to 322.5 statute miles or 517 kilometers.

Your answer: d. 420

Frame 16

That's awfully heavy for 25 gallons, watch the scales - don't change the method of reading the answer. Remember pounds is on the outer scale and gallons is on the inner scale. Return to page 6, frame 12 and review, then try again on page 1 frame 13.

Ans: Yes

Ans: 323 SM

517 KM

Frame 5

Since the scales are the same you can set up ratios and proportions using these scales.

Frame 11

Work these:

1. 300 Stat = _____ naut _____ km
2. 150 Naut = _____ Stat _____ km
3. 75 Naut = _____ Stat _____ km
4. 200 KM = _____ Stat _____ Naut
5. 50 KM = _____ Stat _____ Naut

Frame 17

Good - 150 lbs is correct - continue below.

In the last few frames you have been solving for pounds, now solve for gallons. Use the same computer set up and read the answer on the inner scale. How many gallons in 90 lbs? 15 gal

Continue.

Ans: 1. 260 - 480

2. 173 - 277

3. 86 - 138

4. 125 - 108

5. 31 - 27

Ans: 15 gal.

Frame 6

MILEAGE CONVERSIONS

Often you will need to convert between statute miles, nautical miles, and kilometers. To do this you will use the "stat", "Naut", and "km" indexes. Places the "10" on the inner scale under the "naut" index. The "10" may be used to represent 1 mile, 100 miles or 1000 miles. In this case let "10" represent (100) nautical miles, now you read 115 under "stat". What do you read under "km"? ~~(18.4,~~ (184) ~~or 1840)~~

Frame 12

Occasionally you need to convert gallons of fuel to pounds. This is similar to the mileage conversion that you just finished. Let's try one now. The outer scale represents pounds and the inner scale represents gallons. First set the "10" on the inner scale under the "60" on the outer scale. Notice that if 6 pounds is over 1 gallon (60 over 10), 12 pounds is over 2 gallons (12 over 20), and 18 pounds is over 3 gallons.

Frame 18

Keep reading, 300 pounds is 50 gallons and 3000 pounds is 500 gallons.

Ans: 184 km

Return to page 1 frame 7.

Ans: 18 lbs.

Return to page 1 frame 13.

Ans: 50

500

Continue on page 7.

TEST NO. I

NOTE: Complete Section I, frames 1 through 18, before working test No. 1. You should get at least 5 of the problems correct.

A. 150 gal. = 900 pounds

B. 215 gal. = 1290 pounds

C. 54 gal. = _____ pounds

D. 120 gal. = _____ pounds

E. 168 gal. = _____ pounds

F. 51 gal. = _____ pounds

Ans: A. 900

B. 1290

C. 325

D. 720

E. 1008

F. 306

Continue on page 8 frame 19.

SECTION II

Frame 19

Next you must learn to work time-rate-distance problems. The computer is designed with miles on the _____ scale and time on the _____ scale.
(inner, outer)
(outer, inner)

NOTE: For the remainder of this program we will use Nautical Miles (NM) and speed will be in Knots (k).

Frame 31

Your answer: 2 hr + 05 min.

You must have used the wrong set-up. Remember the speed index must be placed under the speed. Return to page 17 frame 28 and review, then continue.

Frame 43

Without changing the computer look again under 2 miles. Notice the 1:20 therefore the answer could have been ___1___ minutes and ___20___ seconds.

Ans: Outer

Inner

Ans: 1 minute and 20 seconds.

Frame 20

Suppose your speed to be 70K and you maintain this speed for 18 minutes, what distance would you travel? First set the speed index (▲) under the 70 on the outer scale. The speed index is 60 minutes. The set-up you now have means you are traveling 70 miles in 60 minutes therefore, to determine the distance covered in 18 minutes read the value on the outer scale over 18 min. on the inner scale. Your ans:

21 KM

Frame 32

Your answer: C. 29 min.

You must have misread the time. 29 in this case represents 290 minutes. Actually the correct answer is less than 290. Return to page 19 frame 30 and read the hour scale.

Frame 44

If you traveled for 20 seconds at a speed of 70K, what distance will be covered? Place the sec. index under 70 and read over the 20.

The answer is:

A. 39 nm — See page 10 frame 45.

B. 3.9 nm — See page 11 frame 46.

C. .39 nm — See page 12 frame 47.

Ans: 21

Frame 21

Let's review:

In the previous frame you placed the speed index under the speed and read the distance over the time.

Frame 33

Ans: B. 4 hrs + 48 min. Good, continue below.

Some problems will require the time to be computed in seconds and/or minutes instead of hours and minutes. For example, how much time is required to fly 2 nm with a speed of 150K? In this case it is more convenient to use the record index on the inner scale at No. 36.

Frame 45

Your answer: A. 39 nm.

Impossible -- select another answer.

Remember that you traveled only 1/3 of a minute at a speed of just over 1 mile per minute, therefore the distance will be small.

Ans: Time

Ans: Seconds

Frame 22

Solve this one. Speed = 130K; Time = 1 hr + 20 min; Find distance: Set the speed index under 130, then over 1 hour + 20 min (80), read the distance which is 174 nm.

Frame 34

Right: First set the sec index under the 150 on the outer scale. The sec index represents 3600 seconds, or one hour, therefore the ratio is still correct.

Now under 2 miles read the time which is:

A. 48 min. See page 12 frame 35.

(B.) 48 sec. See page 13 frame 36.

Frame 46

Your answer: B. 3.9

You must determine the decimal point by analyzing the problem. Your speed is only 70K -- just a little over a mile per minute -- but you only travel for 20 sec -- not even a minute. Return to page 9 and make another selection.

Ans: 173 nm

Frame 23

Today you are going to drive at a speed of 48K for 2 hours and 15 minutes. By so doing you will travel 108 nm.

Frame 35

Your answer: A. 48 min.

Could this possibly be! Remember you are using the sec index not the minute index. The inner scale is now in seconds, not minutes.

Frame 47

Your answer: C. .39 nm.

Correct. You did a good job of correctly locating the decimal point.

Continue on page 13 frame 48.

Ans: 108

Frame 24

O.K., now try another one:

Speed = 160 K

Time = 1 hour + 20 minutes.

Distance = _____ nm.

Frame 36

Your answer: B. 48 sec.

O. K., Keep on going on page 14.

Frame 48

Now solve for speed:

1. If you traveled 2 nm in 50 seconds, what is the speed? Set the 50 (inner scale) under 2 on the outer scale and read 144 K over the sec index.

2. Distance traveled = 1½ nm.

   Time required = 1 min 20 sec

   Find speed = 67.5 K

3. Distance traveled = 4 nm.

   Time required = 2 min.

   Find Speed = ~~72~~ 120 K

Ans: 213

Ans: 1. 144 K

2. 68 K

3. 120 K

Continue on page 15.

Frame 25

Remember the relationship between distance and time. Suppose the pilot does not know his ground speed in flight but he finds that he flew a 40 nm leg in 18 minutes. To calculate his speed set your computer so that 40 miles (outer scale) is over 18 min. (inner scale). Now read the answer over the speed index. Ans: 133 k

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Frame 37

Remember you are using the sec. index therefore the answer will be 48 (min., Sec.).

Frame 49

The computer is also used to solve fuel problems. When solving a fuel problem you are concerned with time - how long can you fly, rate - how many gallons per hour will you use, and amount - total gallons used or needed.

Ans: 133

Ans: Sec.

Frame 26

Once more, you fly 275 nm in 2 hours and 30 min. Set 275 nm (outer Scale) over 2 hours and 30 min (inner scale) -- notice 2 hours and 30 min is the same as 150 min. therefore you may use either time scale. Now read the speed of 110 K over the speedindex (▲).

Frame 38

Try another one. Find the time required to fly $1\frac{1}{2}$ nm at a speed of 100 K. First set the sec index under 100 K, then read under $1\frac{1}{2}$(1.5) 54 sec.

Frame 50

How long could you fly with 30 gal. if you were using 18 gal. per hour? Set the rate index (▲) under the rate and under 30 on the outer scale you read 1 hours and 40 minutes.

Ans: 110 K

Ans: 154

Ans: 1 hour and 40 min.

Frame 27

Practice with these problems:

A. Given: Distance = 170 nm.
Time = 1 hour and 10 min.
Find Speed 146 k.

B. Given: Distance = 340 nm.
Time = 3 hours
Find Speed = 113 K.

C. Given: Distance = 16 nm.
Time = 4 min.
Find Speed 240 K

Frame 39

How much time is required to travel 2 nm at a speed of 90K? (Use the sec. index). Select One:

A. 13.3 sec. See page 18 frame 41.

(B) 80 sec. See page 17 frame 40.

C. 5 min. See page 19 frame 42.

Frame 51

Suppose on another flight you are using 15 gal. per hour. How long would it take to use 10 gal.? Again set the rate index (▲) under the rate and read 40 min. under the fuel - (remember fuel is on the outer scale).

Ans: A. 146 K

B. 114 K

C. 240 K

Ans: 40 min.

Frame 28

From the previous problems you have learned to solve for speed (rate) and distance. During pre-flight planning the aviator knows the distance to be flown and the groundspeed he expects to have. He must find the estimated time enroute (ETE) to enter on the flight Plan. To solve for time set the speed index under the speed and read the time (on inner scale) under the dot (on the outer scale).

Frame 40

You are correct. Onward.

Continue on page 8 frame 43.

Frame 52

Now find the rate of consumption if you use 45 gal. in 2 hours and 10 min. Remember the fuel on the outer scale is over the time on the inner scale and the rate in this case is 20.8 gal. per hour.

Ans: Distance.

Ans: 20.8 GPH.

Frame 29

How much time is required to travel 180 nm at a speed of 120K? First set the speed index under 120 and read the time under the distance (180). In this case it would require ___1___ hours and 30 minutes.

Frame 41

Your answer: A. 13.3 sec

You did not follow instructions. You placed the speed index under 90. Return to page 11 frame 34 and read again. Then go to page 16 and select another answer.

Frame 53

Suppose you fly for 3 hours and 40 min. using 17 gal, per hour; find the fuel required. Start by setting the rate index (▲) under the rate and read the fuel required over the time. Your answer: 63.5 gal.

Ans: 1 hour and 30 min.

Ans: 62 gal.

Frame 30

During preflight you find that you must travel 375 nm at a speed of 78K, this would require (pick one below):

a. 2 hours and 05 min. See page 8 frame 31.

(b) 4 hours and 48 min. See page 10 frame 33.

c. 29 min See page 9 frame 32.

Frame 42

Your answer: C. 5 min.

Did you read from the inner scale out? That's wrong, try another time.

Frame 54

Next try these:

1. Rate = 12 GPH (gal/hour).
   Fuel = 68 gal.
   Find Time 5 hr.

2. Fuel = 35 gal.
   Time = 1 hour and 45 min.
   Fine rate 20 GPH.

3. Rate = 16 GPH.
   Time = 2 hours and 08 min.
   Find Fuel required: 34.5 gal.

Ans: 1. 5 hours and 40 min.

2. 20 GPH.

3. 35 gal.

TAKE TEST NO. 2 ON PAGE 20.

CRITERION TEST NO. 2

1. DISTANCE CONVERSIONS:

	Nautical Miles	Statute Miles
a.	140	
b.		42
c.		420
d.	168	
e.	189	
f.		222

2. TIME - SPEED - DISTANCE:

	TIME	GS	DISTANCE
a.		110k	242 nm
b.		120k	180 nm
c.	90 min	108 k	36 nm
d.	1 hr + 18 min	116k	98
e.	1 hr + 20 min	64.5 k	86nm
f.	36 min	115k	69nm

3. FUEL COMPUTATIONS:

	TIME	RATE(GPH)	FUEL(Gal.)
a.	2 hr + 10 min	23	50
b.	1 hr + 30 min	11	
c.	6 hr	23	138
d.		9	42
e.	4 hr + 20 min	23.4	102

NOTE: Turn page to check your answers.

ANSWERS:

1. a. 161
   b. 36.5
   c. 365
   d. 194
   e. 218
   f. 193

2. a. 2 hrs and 12 min.
   b. 1 hr and 30 min.
   c. 20 min.
   d. 150
   e. 64
   f. 69

3. a. 50
   b. 16.5
   c. 6 hrs.
   d. 4 hrs and 40 min.
   e. 23.5

NOTE: Continue on page 21 frame 55.