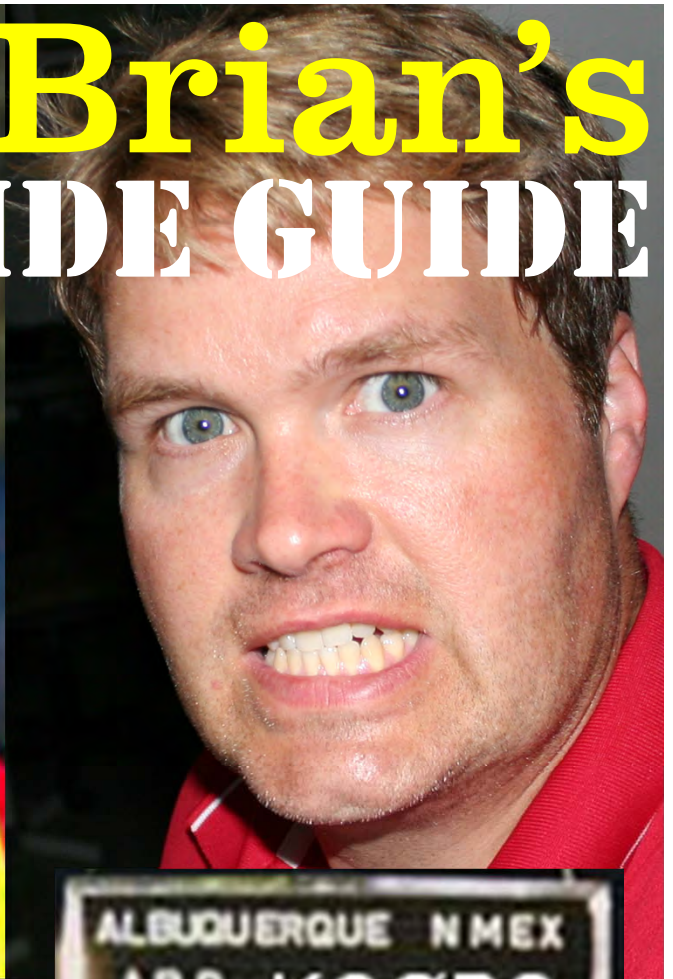


Matt & Brian's STOLEN SLIDE GUIDE



POLICE DEPT.
JACKSON, MISS
KC4WCG



ALBUQUERQUE NMEX
APO KCØBS
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EXTRA

Class!

Amateur Extra Study Guide

Courtesy WINXC



Extra Class Amateur Radio Element 4
FCC License Preparation

INCLUDES FREE COMPANION CD!

Contains the Complete 738-question FCC Element 4 question pool effective July 1, 2008 to June 30, 2012

- Questions Reorganized for Logical, Easy Learning
- Educational Explanations Teach You Extra Class Fundamentals
- Handy Extra Class Formulas
- Over 100 Addresses of Helpful, Educational Web Sites
- Highlighted **Key Words** for Every Explanation
- Fully-illustrated Text Aids Learning
- Frequency Chart Shows Privileges
- List of VEC Examiners

**UPGRADE TO THE TOP
HF WORLDWIDE HAM LICENSE**

by **Gordon West**
M3S208

INCLUDES COMPANION CD & COUPONS

- GORDO'S CD DEMONSTRATES HF EXCITEMENT & TEACHES EXTRA CLASS OPERATING PRINCIPLES!
- FREE CQ MAGAZINE TRIAL SUBSCRIPTION!
- FREE BOOK WITH ARRL MEMBERSHIP!

A photograph of a man in a green polo shirt sitting at a desk in a radio shack. He is wearing large headphones and looking at a laptop. On the desk are various pieces of radio equipment, including a microphone and a control panel. The background shows a window with a view of a green landscape.

Amateur Radio Extra Class Element 4 Course Presentation



➤ **ELEMENT 4 Groupings (from the book)**

- **Rules & Regs**
- **Skywaves & Contesting**
- **Outer Space Comms**
- **Visuals & Video Modes**
- **Digital Excitement with Computers & Radios**
- **Modulate Your Transmitters**
- **Amps & Power Supplies**
- **Receivers with Great Filters**
- **Oscillate & Synthesize This!**
- **Circuits & Resonance for all!**
- **Components in Your New Rig**
- **Logically Speaking of Counters**
- **Optos & OpAmps Plus Solar**
- **Test Gear, Testing, Testing 1,2,3**
- **Antennas**
- **Feedlines & Safety**

EXTRA CLASS STUDY GUIDE

October 2010-By Ed W1NXC



The key to successfully answering any multiple-choice exam is primarily based on the applicant reading the questions carefully.

In many instances, however, the so-called detractor answers are not only confusing, but also blur the intent of the question, i.e., to find out if you really know the material.

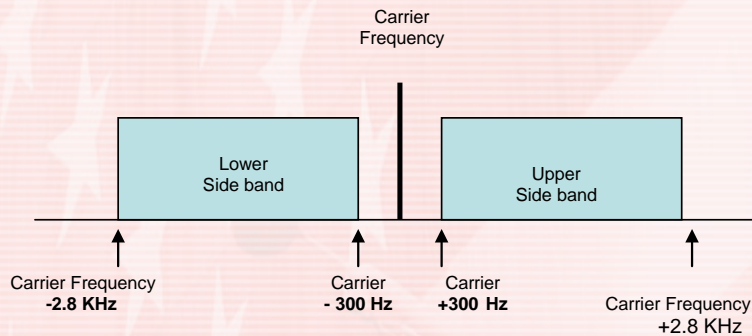
This study guide will assist you on concentrating on the RIGHT answers. Note that in many cases throughout this guide the right or CORRECT answers are capitalized and easy to spot. Study this guide carefully and notice that the keywords that are in CAPITAL letters point you to the right answer.

Remember also that a little study of the text may also be of some help, since the Extra pool has 50 questions, and you need 37 correct

FCC Rules



- Remember: **USB emission** is AM, standard, normal voice needs about **3kHz** for readability
Example: 14.349 is TOO CLOSE to band edge(See E1A09)



- CW ONLY** band- **30 meters**
- Watch out for questions on **60 meters**, **50 Watt max**, **dipole only**, **specific channels**, **USB only**
- Note that **EXTRA** has **NO** special privileges on **160, 30, or 10** meters

FCC RULES



- For RULES violation , **control op** is **accountable**
- Ship or aircraft operation, **need permission** of CAPTAIN or PILOT
- In **international** waters, need alien license/amateur license
- **SPURIOUS** means **OUTSIDE the band** emissions
- Antenna location ?-can **not** affect **ENVIRONMENT, HISTORY, or CULTURE!**
- Keep **ONE MILE** from **FCC Monitoring station!**

FCC RULES



- If antenna in wilderness location, need **ENVIRONMENTAL** assessment.
- **Near airport** ? If within 4 miles, must notify FAA and **register** with FCC, and antenna must be less than **200 feet** up.
- For **QRM on GOOD DESIGN** Broadcast Station, eliminate QRM on the frequency that is causing it.

FCC Rules



- Questions on **RACES**, watch for keyword **CIVIL DEFENSE** in one of the choices.
- **All amateur frequencies available** unless President's war powers are enacted-then only **SPECIFIC** frequencies.
- **Remote Control** requires **CONTROL LINK**
- **Automatic Control - NO OP** at Control Point
- **Local Control** - direct control by OP
- **Automatic Control** for **10 METERS** ONLY(29.5 to 29.7MHz)
- **Beacon , Earth or model aircraft** may **NOT re-transmit** signals

FCC Rules - Satellites



- **Telemetry** is one-way **MEASUREMENT**
- **Satellite** service is **NOT NAVIGATION, WX, OR LAUNCHING**
- **Telecommand** INITIATES, NOTIFIES, TERMINATES
- **Satellite station**, within 50 Km of earth **must cease if FCC orders**
- Remember: **NO space operation** on **30 or 12** meters
- On **VHF** only **2 meters authorized** for space stations

VEC RULES



- **Minimum of 3 VE's** required
- must be **present** at all times during the exam session
- **NO** relatives
- must **grade test at once**
- **each VE** is fully **responsible**
- **Out-of-pocket expenses allowed** for VE's
- must be **at least 18 years old** to be accredited
- Note: **penalty** for failing to appear for FCC retest is **LOSS OF LICENSE!**

FCC RULES



- Maximum power allowed for **SPREAD SPECTRUM** is **100 Watts**
- Only permitted **ABOVE 222 MHz**
- Frequency hopping(FREQUENCY CHANGES) or Direct Sequence (BINARY BIT STREAM)
- **Auxiliary** station control ? **NO NOVICES!**
- FCC may issue **STA(Special Temporary Authorization)** for **EXPERIMENTAL** amateur communications
- **CEPT** agreement-E stands for **European**
- **IARP** agreement-P stands for **Peru(So. America**
- **Line A?**-see A in **Canada**-10 MHz slice at 420-430 MHz
- **Quiet Zone** ?- keyword **ASTRONOMY**
- **Message to business** ok if **NO MONEY** involved
- **Communications for hire** is a **NO NO!**

FCC RULES



Satellite questions

- **Ascending** pass is **SOUTH to NORTH**,
- **Descending** pass is **NORTH to SOUTH**

- **Mode U/V** is UHF/VHF -satellite **RECEIVES** on **UHF**

TV questions

- JT65 Coding ? **Keyword** is **PERFECT**
- **Vestigial** transmission is **AMPLITUDE** modulation
- **CHROMA** segment is **color** information
- **Slo-scan** uses SSB, 128 or 256 lines, tone determines brightness,
- **VIS** (Vertical Interval signaling) determines **Mode** for SSTV

- **FMTV**(Frequency Modulated Television) found on 1255MHz
- **Bandwidth** must not exceed VOICE
- **Standard TV(Fast scan)** is NTSC-Black is 7.5 IRE units

CONTESTING QUESTIONS



No log is required

SELF-SPOTTING is a NO NO!

Contesting is allowed but **not done usually** on **60, 30, 17, or 12M**

Most Activity on **WEAK signal portion** of the band

CABRILLO is a **standard** logging program

146.52 is National Calling Frequency **not used** for contesting

DATA



TNC command mode (CMD) means **READY TO RECEIVE** instructions

Baud is number of **DATA SYMBOLS** per second

HF packet uses **300** Baud

2 Meter packet uses **1200** Baud

Relay messages in Packet by **STORE & FORWARD**

2 meter APRS frequency is only ODD one (**146.39MHz**)

APRS with GPS shows **POSITION**

APRS Data Protocol is **AX25**

UNNUMBERED Informational Frames used for **APRS Beacon Data**

Best Data Rate for HF is **300 Baud**

For **Binary files** use **PACKTOR**

PSK31 is most EFFICIENT with narrowest bandwidth

When you see the word **BAUDOT** look for keyword **FIVE!**

PROPAGATION



- **EME**(Earth Moon Earth)is best when moon at **PERIGEE**(Low)
- Need very low NOISE FIGURES - **OK if both can see moon**
- **EME** found at low end of 2 meters, **144.000 to 144.100** and also at **432-432.100 MHz**.
- **Meteor Scatter** - ELECTRONS at **E LAYER**-use 15 sec sequence
- **Trans-Equatorial** is up to **5000 miles N & S** of Equator
- **LONG PATH** is 180 degrees, 160 to 10 M ok, 20 Meters best
- **ECHO** caused by **More than one path**

PROPAGATION



- **GRAY LINE** best sunrise & sunset, good for 8 to 10000 miles
Keyword: **TWILIGHT**
- **Auroral** signals are **FLUTTERY**, at E region, caused by CHARGED particles from sun, **best reception is CW**
- **Fading** caused by **PHASE** differences
- **VHF/UHF** **exceeds** horizon by **15 percent**
- **Beam** antenna **take off angle** **DECREASES** with **height**
- **DUCTING** sends **VHF** signal farther
- **PEDERSEN** wave is higher wave **penetrating F2 layer**
- Horizontal antenna **on hill** ?-take-off angle **DECREASES**
- A **ground wave** is **VERTICAL** - Radio waves **BEND**



Meter measuring questions

A spectrum analyzer **horizontal** axis shows **FREQUENCY**
Vertical axis shows **AMPLITUDE**-Must ATTENUATE input
Good to display **SPURIOUS** and **INTERMODULATION**

Antenna analyzer measures **SWR(standing wave ratio)**

For **PSK operation**, adjusting **ALC level** most important

NPN transistor On condition -Base-to-emitter **.6 to .7 volts**

Logic probe indicates **PULSE** conditions in digital circuit

Harmonic Frequency marker needs **FREQUENCY STABILITY**

Accuracy of **Frequency Counter** depends on **TIME BASE**

A **Bridge** measures **impedance** because of NULL reading

Frequency Counter problems (E4B04,05,06) **Watch DECIMAL point!**

For **Oscilloscope** measurements **keep GROUND short!**

For **intermodulation** tests use **NON-HARMONIC** tones

Meter measuring questions



Couple dip meter LOOSELY-square wave should be FLAT

COIL IMPEDANCE important for D'Arsonval meter

Thermal noise value of receiver-SMALLEST number

Noise figures reflect SIGNAL to NOISE

Biggest problem - **ATMOSPHERICS!**

For **RTTY** use **300 KHz** filter

For **SSB** use **2.4 KHz** filter

For **FM** use **15 KHz** filter

If filter too wide, then comes QRM!

Roofing filter improves **DYNAMIC** range

NOISE / QRM ISSUES



Intermodulation caused by MIXING-use CIRCULATOR

Preselector improves REJECTION

DSP filter reduces **ALL NOISE** types

For motor noise,

- **DIRECT** battery connection and **BRUTE FORCE** filter
- DSP notch filter may **remove DESIRED** signals

Computer QRM is **whining sound**

RESONANCE QUESTIONS



At resonance - circuit **impedance** equals circuit **resistance**

In **SERIES** circuit input current is **MAX** at resonance

In **PARALLEL** circuit input current is **MIN** at resonance

In one half bandwidth problems, divide Q into Freq

-watch out for decimal point

-one problem has a bandwidth answer of 1.89KHz,
which is much too small to be correct.

In resonant frequency problems **most answers are in the band!**



TIME CONSTANT PROBLEMS

Remember: **$T = RC$**

time in seconds,
R in Ohms,
C in Farads

In ONE time constant capacitor charged to **63.2%** of value

Keep that in mind and watch decimal point

PHASE ANGLE PROBLEMS



If X_C larger than X_L , then voltage **LAGS**
If X_L larger than X_C , then voltage **LEADS**
Correct answer is always **SMALLER angle**

100 ohms capacitive, 100 ohms inductive, 100 ohm resistive?
angle is obviously 0 DEGREES at 100 ohms

If circuit capacitive, angle is **NEGATIVE**
If circuit inductive, angle is **POSITIVE**

Example: 400 ohms inductive in parallel with 300 ohms resistive,
then circuit is **INDUCTIVE** and look for answer in **POSITIVE** degrees!

If reactance equals resistance, angle **has to be 45 degrees**

Energy is measured in **JOULES**--Power factor equals cosine theta
TRUE power equals **APPARENT** power **times** power factor

CIRCUIT COMPONENT QUESTIONS



N-type has more free electrons
In **P-type** HOLES are carriers

ACCEPTOR adds,

PNP (pointing in),
NPN (Not pointing in)

ALPHA is change in Collector current to **Emitter** current

BETA is change in Collector current to **BASE** current

ALPHA cutoff frequency is .7 gain at 1 KHz

MORE CIRCUIT COMPONENT QUESTIONS



Depletion mode **FET** has current flow with NO gate voltage

N channel DUAL gate -see arrow pointing IN

FET has **HIGH** input impedance,
Bipolar has LOW input Z

P-type has fewer free electrons,
N-type majority carriers are free electrons

An **FET** has a **GATE, DRAIN and SOURCE**

MORE CIRCUIT COMPONENT QUESTIONS

DIODES



ZENER diode has CONSTANT voltage, VARYING current

TUNNEL diode has NEGATIVE resistance region

VARACTOR diode varies internal capacitance

HOT CARRIER diode used as UHF mixer or detector

PIN diode used as RF switch

POINT CONTACT diode used as RF detector

JUNCTION diode-TEMPERATURE limiting



MORE CIRCUIT COMPONENT QUESTIONS

For **TTL** circuits-use 5 Volt supply

In **TTL** logic, Hi is 2.0 to 5.0 volts, Lo 0.0 to .8 volts

CMOS advantage -**LOW POWER** consumption and **immunity to noise**
(switching is one-half power supply voltage)

Vidicon beam varied by **ELECTROMAGNETIC** fields

CCD device **SAMPLES** analog signals, **STORES** charges

Crystal lattice filter has **NARROW** bandwidth and **STEEP** skirts

Crystal frequencies determine **BANDWIDTH**

Piezo-Electric effect depends on **VOLTAGE**

MMIC's use 50 Ohms, microstrip construction, 12 volts

MMIC noise figures typically are 3.5 to 6 dB, use plastic



OPTICAL DEVICES

Visible light - **CADMIUM SULFIDE**

Infrared - **LEAD SULFIDE**

Optoisolators have **HIGH IMPEDANCE, ISOLATION**

Best for **photo voltaic use** is **GALLIUM**

Most common is **SILICON** - keyword **5 VOLTS**

Bi-Stable is FLIP-FLOP,

Unstable is Astable

TRUTH table has input and outputs

AMPLIFIER QUESTIONS



Class AB conducts more than 180 but less than 360 degrees

Most efficient ? C, to tune amp dip plate, tune for Max

Grounded grid amplifier has **LOW** input

PUSH-PULL amp eliminates **even-order** harmonics

Don't use class C for SSB - causes **DISTORTION!**

Neutralize ? Out-of-phase output to input

FILTER QUESTIONS



Chebyshev - RIPPLE, SHARP CUTOFF

Elliptical - DEEP NOTCHES

Notch filter use for AUDIO

Remove noise with **ADAPTIVE** filter

For 2 meters use **CAVITY** filter

To generate SSB use **HILBERT** transform

PI network useful since Q can be varied

Digital circuits most affected by **NON-LINEAR** devices

Linear voltage regulator has **ZENER** for control

SERIES most efficient, **SHUNT** has constant load

Conventional power supplies more **COMPLEX, BIGGER**

MODULATION AND DEMODULATION



Phase modulation varies the TANK circuit

SSB is generated by a **BALANCED MODULATOR & FILTER**

At the **transmitter** we have **PRE-EMPHASIS**

At the **receiver** we have **DE-EMPHASIS**

When signals **MIX**, there is **SUM & DIFFERENCE**

Excessive signal or drive causes **SPURIOUS**

To **demodulate SSB** use PRODUCT DETECTOR

To **demodulate FM** use FREQUENCY DISCRIMINATOR

A prescaler DIVIDES,

A **decade** counter counts **10 in, 1 out**

Xtal **oscillator frequency divider** needs **TIME BASE ACCURACY**

MODULATION AND DEMODULATION



OP amp depends on **EXTERNAL** components

Op amps exhibit gain, do not **VARY** with frequency

Op amps have HIGH **input** impedance, LOW **output** impedance

To find **gain**, divide **smaller number** into **larger number**

Ringling is caused by **poor PHASE** response

A **phase-locked loop** does frequency synthesis, FM demodulation

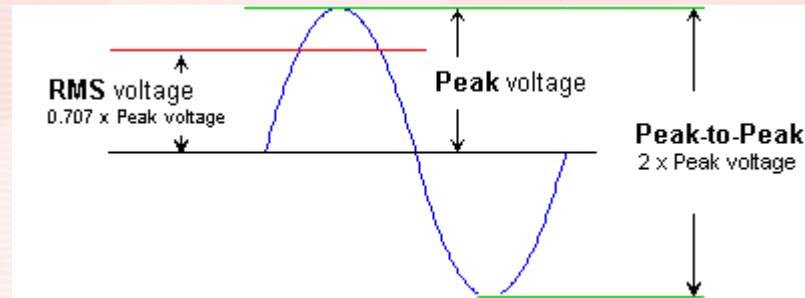
Phase-locked loop problem? - **BROADBAND NOISE**

SIGNALS AND EMISSIONS QUESTIONS



Square Wave-keyword ODD,
Sawtooth wave-FAST RISE TIME

Peak Envelope Power to
average power is **2:1**



Human speech is **IRREGULAR**

Data pulses are short **BURSTS OF ENERGY**

Analog to digital conversion uses **SEQUENTIAL SAMPLING**

Modulation index does **NOT** vary with **frequency**

Pulse transmission -**ONE** short pulse, **LONG** interval

BAUDOT code uses **FIVE** data bits

ANTENNAS AND RADIATION PATTERNS



For evaluating antenna performance, use **METHOD of MOMENTS**

NEC stands for **Numerica, Electromagnetics Code**

Antenna modeling program can check **SWR, GAIN, POLAR PLOT**

Phased antenna questions: 180 out of phase is **ORIENTED**
90 out of phase is **CARDIOID**
In Phase is **BROADSIDE**

Basic **Rhombic** antenna is **BI-DIRECTIONAL**
Terminated Rhombic becomes **UNI-DIRECTIONAL**

All **Rhombics** require sturdy support and large area



ANTENNAS

BEVERAGE antenna must be **more than ONE** wavelength

In a **parabolic** antenna, if frequency **doubled** - gain rises **6 dB**

Beamwidth DECREASES with gain-Loading coils in **CENTER**

Loading coils cancel **CAPACITIVE REACTANCE**

Traps allow **MULTI-BAND** operation

For **grounding** use **THIN, COPPER STRAP**

INTERCONNECTED ground rods are best

ANTENNA MATCHING PROBLEMS



GAMMA-for unbalanced feed, **compensates** for **capacitive reactance**

DELTA-connects in 2 places, **matches Hi Z to Lo Z**

STUB-made from sections of transmission line

HAIRPIN-matches line to **YAGI**, reactance must be **CAPACITIVE**

For a **50 OHM** feed to **grounded tower**, use **GAMMA** match

A **WILKINSON** divider provides **EQUAL POWER**

For **coaxial** cable **VELOCITY FACTOR** is **.66**

Ladder line has **LOWER** loss than **coax cable**



FEEDLINE AND CABLE QUESTIONS

Foam dielectric cable outperforms **SOLID**

$1/8$ wave transmission line **shorted** is **INDUCTIVE**

$1/8$ wave transmission line **open** is **CAPACITIVE**

$1/4$ wave transmission line **shorted** is **HIGH Z**

$1/4$ wave transmission line **open** is **LOW Z**

$1/2$ wave transmission line **shorted** is **LOW Z**

$1/2$ wave transmission line **open** is **HIGH Z**



SMITH CHART QUESTIONS

These can check **SWR, IMPEDANCE, WAVELENGTH**

Normalizing ? key word **PRIME CENTER**

Only **straight line** is **RESISTANCE**

For **DF (Direction finding)** use **large coil**

Attenuate to avoid overload, needs "sense" antenna

Sense antenna makes loop pattern **CARDIOID**

RADIATION QUESTIONS



Radioactive radiation breaks apart atoms, **RF does NOT**

Ensure your signals less than UNCONTROLLED MPE

Use **computer-base** antenna **MODELING** program

FARFIELD-where antenna pattern independent of distance

SAR is **SPECIFIC ABSORPTION RATE**

Most dangerous? **BERYLLIUM OXIDE**

Watch out for **RADIATION** leaks

FOCUS



There are 738 questions in the pool as released in 10 Sub elements, E1- thru E0. The Question topics for each element are given below and along with the number of questions total that will be included from each element on you exam. We suggest you concentrate on those areas you can learn easily and those with the most questions in the exam. Elements with 8 questions are clearly more important than those with one question from the pool.

SUBELEMENT E1 -- COMMISSION'S RULES	[6 Exam Questions 6 Groups]
SUBELEMENT E2 -- OPERATING PRACTICES & PROCEDURES	[5 Exam Questions 5 Groups]
SUBELEMENT E3 -- RADIO WAVE PROPAGATION	[3 Exam Questions 3 Groups]
SUBELEMENT E4 -- AMATEUR RADIO TECHNOLOGY & MEASUREMENTS	[5 Exam Questions 5 Groups]
SUBELEMENT E5 -- ELECTRICAL PRINCIPLES	[4 Exam Questions 4 Groups]
SUBELEMENT E6 -- CIRCUIT COMPONENTS	[6 Exam Questions 6 Groups]
SUBELEMENT E7 -- PRACTICAL CIRCUITS	[8 Exam Questions 8 Groups]
SUBELEMENT E8 -- SIGNALS AND EMISSIONS	[4 Exam Questions 4 Groups]
SUBELEMENT E9 -- ANTENNAS AND TRANSMISSION LINES	[8 Exam Questions 8 Groups]
SUBELEMENT E0 -- Safety	[1 exam question 1 group]

Total: 50 Exam Questions 37 Correct to pass

FINAL REMINDER



Use this study guide
as an aid in careful study
of the Extra class manual!

The book cover for "Extra Class" is green with a white grid pattern. At the top left, the title "Extra Class" is in large yellow font, with "Amateur Radio Element 4 FCC License Preparation" in smaller white text below it. A circular badge in the top right corner says "INCLUDES FREE COMPANION CD!". The cover lists several features: "Contains the Complete 738-question FCC Element 4 question pool effective July 1, 2008 to June 30, 2012", "Questions Reorganized for Logical, Easy Learning", "Educational Explanations Teach You Extra Class Fundamentals", "Handy Extra Class Formulas", "Over 100 Addresses of Helpful Educational Web Sites", "Highlighted Key Words for Every Explanation", "Fully-illustrated Text Aids Learning", "Frequency Chart Shows Privileges", and "List of VEC Examiners". A photograph on the right shows a person wearing a headset at a desk with a computer and radio equipment. At the bottom, a yellow banner says "INCLUDES COMPANION CD & COUPONS" and lists: "GORDO'S CD DEMONSTRATES HF EXCITEMENT & TEACHES EXTRA CLASS OPERATING PRINCIPLES!", "FREE CQ MAGAZINE TRIAL SUBSCRIPTION!", and "FREE BOOK WITH ARRL MEMBERSHIP!". A small badge at the bottom left says "by Gordon West".